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THE CO-ORDINATION OF ROAD AND RAIL TRANSPORT

THE recent announcement of the surplus Railway Budget by the Communications Member must, no doubt, have come to the public as a very welcome departure from the somewhat unpleasant reading which previous Railway Budget speeches have provided. The impressive surplus of over 14 crores, which, as the Railway Member has confessed, surpasses all official estimates. This, however, should not lead us to complacency. It is a matter of common knowledge that this windfall for railway revenues is the direct result of the Railway Board's policy of upward revision of railway rates and fares announced last year, and the unprecedentedly heavy military traffic that is being moved by the railways. The railways themselves cannot claim much for any increased efficiency that might become apparent by a close scrutiny of railway operation. It is, therefore, clear that the public, as much as the railways themselves, must be on their guard against any over-optimism, as the conditions, under which such huge incomes are being earned, are abnormal and are bound to give way, in their turn, to less favourable circumstances.

War conditions, under which the railways of the British Empire are operating, have brought on many fresh problems, and have emphasised the importance of some of the old ones. The recent enquiries conducted by expert committees into the problems of wagon turn round, dearness allowances for railway workers, etc., are evidences of this. Among such problems one of the most important is the co-ordination of road and railway transport (the need for which was

recently voiced by Mr. Scot in the legislature), so as to produce an integrated scheme of services, capable of giving the cheapest and most efficiently organised means of transport to the community as a whole. In Great Britain, where the railways and road services are operating "under fire", the problems arising out of road-rail competition have, at least temporarily, been relegated to the background. In India, where uneconomic competition is very rife, the importance of this problem needs no emphasising.

Historically the growth of road-rail competition was, at least in part, due to the last World War. In England during the pre-war days competition in transport was mainly between the railways themselves. This competition has almost disappeared after the amalgamation of 1923, and the various pooling arrangements that came into force since then. After the demobilisation following the peace treaty a large number of military lorries were rendered superfluous to the Army and became available for sale at reduced prices. Many of the demobilised men, who had learnt to handle lorries during the period of national service, turned to the plying of motor lorries for hire, or reward as a profession, and this brought them into direct competition with the railways. An era of unbridled competition between these two forms of transport followed. In fact the transport history of Great Britain since the last war is a review of the efforts made by the State and the railways to evolve a co-ordinated scheme of passenger and freight transportation for the country.

In India road-rail competition has grown on somewhat similar lines, although, on the whole, it is much less acute. One important factor, that has tended to restrict the field of operation of the road haulier in India, has been the paucity of good roads until recently and the great distances between the various centres. The first of these is fast disappearing with the rapid improvement in road building, and ambitious programmes, which have been executed since the utilisation of the Road Fund out of the Petrol Tax, have become an established policy of Government. The phenomenal development in the design of the internal combustion engine has considerably strengthened the position of the road haulier to hold his own even over long hauls, which were formerly regarded as the especial domain of the railways. One thing, however, that has favoured the railways is the lack of organisation on the part of the road hauliers, but even this is quickly being made good, and much lost ground has been made up. Government control of transport undertakings, petrol, tyre, etc., rationing and the commandeering of motor vehicles may mitigate the severity of competition, but will be only a temporary spasm of relief. To be forearmed with schemes for the co-ordination of transport services against the arrival of an era of post-war peace and prosperity is an elementary precaution.

Attempts at the co-ordination of transport fall under two groups, *viz.*, measures adopted by the State through legislation calculated to control and restrict wasteful competition, and schemes promoted by the transport interests themselves by agreements, etc. It is clear that every country has to develop its own methods of co-ordination best suited to its individual requirements, and no panacea capable of universal application has yet been devised.

Before considering the methods adopted

for co-ordination it is just as well that we had an idea of the criteria upon which the efficiency of a transport service is judged from the consumer's point of view. The prospective passenger at the very outset demands easy accessibility to stations, information, tickets, etc. In this matter many places in India suffer as the result of lack of foresight on the part of the pioneers of railway transport in India. Adequacy of accommodation, punctuality, cleanliness, the guaranteeing of services and the ready availability of the amenities of travel loom large in the passenger's choice of the mode of transport. The trader desires prompt delivery of goods, freedom from damage or loss. Apart from these the management has its own standard for measuring domestic efficiency. Contented staff, minimisation of waste, and the incidence of accidents and the provision of safe and speedy transport at the lowest cost are the declared aims of all administrations. To the student of transport economics it is of immense interest to study and find out how far these ideals of service are capable of achievement by a co-ordination of the means of inland transport.

It is well known that for certain types of traffics the one or the other method of transport will be the better suited one. For instance, in the case of highly rated traffic moving rapidly in small lots over short distances, road transport easily scores over rail, and perhaps the day is not far distant when the aeroplane may replace the motor lorry. On the contrary, when, say, a huge transformer weighing a hundred tons or a gigantic modern naval gun has to be transported from one end of the country to the other, there is nothing that can touch the railway in the accomplishment of such a feat.

In this connection it is of considerable interest to investigate what weighs with a prospective customer of transport in the choice of the method. Only after understanding why one form of transport is preferred under given circumstances, will it be possible to devise a scheme whereby the different forms of transport can be so co-ordinated as to give the best and cheapest service, by doing away with the shortcomings of the type of transport not preferred, if that is the cheaper to produce. Recently in the United States a questionnaire asking under various heads why road transport was preferred to rail haulage was circulated nation-wide through the medium of the press. The replies make very interesting reading. The reasons determining the choice of the particular method of transport may be divided under service, cost and personal inclination or interest. The road haulier affords cheaper service by reducing packing requirements, lower rates, simpler accountancy and less incidence of damage and faster transport by later acceptance of goods and more flexible services. The same questionnaire also revealed that many did not prefer road transport to rail on account of lack of responsibility or failure to maintain proper services and the non-uniformity of rates or excessive loss or damage. It is of great importance that railways should study by similarly eliciting public opinion on the facilities they provide while shaping their commercial policy.

Before any method of co-ordination of transport becomes successful it is essential to have a clear idea of what types of traffic are best suited for one or the other method of transport. Another important point to be borne in mind is that road transport has come to stay, and all measures adopted by

the state or the railways should be directed towards the organisation of the two as complementary services, neither seeking to divert all the traffic to itself, and thereby occasioning wasteful competition, inconvenience and vain effort. At this stage it will be useful to note, in passing, what handicaps the railways suffer from, which have made road-rail competition such an unequal one. The railways in most countries of the world were partly, if not entirely, financed by the state. This has made the state reserve to itself certain rights, which have militated against railways being run entirely on a commercial basis. The first and perhaps the most important one is the limits imposed by the state within which the railways must quote rates, unless specifically permitted by the government to do otherwise. The railways cannot therefore reduce rates below a certain level to attract a special flow of traffic in competition with a road haulier, or put up its rates, should this be necessitated by commercial expediency. Then there is the "Undue Preference Clause" which prohibits any special treatment to any particular trader as against another. The road haulier is not similarly bound by restrictive regulations. The railways which have invested vast capital on track, rolling stock and other equipment find that in order to earn the standard revenue laid down by the government they must lay down a certain level of charges, having due regard to risks of conveyance, the capacity of the traffic to bear the rate, the type of stock to be provided, the capitalisation of the section of line, weights in relation to the bulk of the commodity and the loading qualities of the traffic. Railway rates are therefore higher than road rates, as road hauliers have an elementary method of rate-fixing, not being obliged to take into consideration the above factors, while building up their rates. Again the railways have scrupulously to observe every labour convention and see that their staff are not incurring too much "long hours of duty" and pay for overtime. In the case of the road haulage industry, for the most part, the small units are owner-operated, and the question of labour legislation observance does not come in at all. Also the commercial railway lines have to make good at least, in part, the loss in the working of the strategic lines. The plea for a "Square Deal" for the railways is therefore a very well-founded one.

In the matter of the co-ordination of their transport services different countries have adopted different methods. State control, by compulsorily nationalising their transport industry, and the enforcement by legislation that a particular method of transport should confine itself to the carriage of certain types of traffics under specified conditions are an ideal which is hard to achieve, except under totalitarian auspices. In India and Great Britain competition, within limits, in the field of transport has been regarded as essential to prevent monopolistic exploitation. In these countries neither road nor railway transport is entirely under government control. The same is true in America. The state being the supreme law giver can, by regulating legislation, and by a judicious road policy, so shape its transport system that the two methods of transport work as complementary units, performing the work best suited to itself and rendering the community the best service. The recent enactment by the Government of India of the Motor Vehicles Act has, by a system of licensing

lorries, done much to control uneconomic competition. Sometime ago the Sind Government undertook not to build a certain road, which would run parallel to the railway, and for which there was little traffic justification. Such action by the State has tended to keep the road operator to his field. A line of enquiry, which suggests itself at this stage, is the possibilities of the co-ordination of suburban passenger transport. In the larger cities of India like Bombay, Calcutta and Madras there is an enormous amount of passenger traffic carried by the suburban lines of the railways, the buses and trams. It is needless to say that there is some degree of competition between these, and the service rendered at present, though good, is capable of further improvement, if they are brought under a unified control, or if some method of the pooling of receipts and services is evolved. The value of such a system of control gains added emphasis in times of emergency. Besides the recent forecast by the Communications Member, that an enhancement in the near future of the suburban season ticket fares is not to be ruled out, might have the effect of diverting a considerable volume of passenger traffic to road (thereby adding to the congestion of city roads), should the forecast come true, unless there is also a corresponding increase of bus and tram fares. The latter can be assured most easily, if all the suburban services are operated by a single authority. One of the most succeseful experiments in this direction is the setting up of the London Passenger Transport Board in 1933, whereby the whole of the road and rail passenger services in the London suburban area was brought under a single authority, and the suburban passenger traffic receipts of the main line railways were pooled with those of the L.P.T.B., and each of the five parties received a fixed proportion from the pool, depending upon the extent of the suburban passenger services operated by each. The same type of co-ordination of passenger transport has been adopted in the city of New York.

Among the numerous methods adopted by the railways to avoid wasteful competition between them and the road transport undertakings may be mentioned their agreements with the road haulage industry. These agreements have sometimes taken the form of financial interests being acquired by railways, or buying up the business of road hauliers. In certain cases the railways have agreed with the road hauliers to provide services to fill in the gaps in railway services or to supplement them in outlying districts, or to act as feeders to a railhead. These agreements have proved very fruitful. In India the Nizam's State Railway has acquired a monopoly for road haulage as well in the State and has been able to produce a remarkable system of integrated services. The East Indian and S.I. Railways have been running long distance road services, and thereby affording a service, which has all the advantages claimed for road transport. This cannot however be called co-ordination, but is a case of successfully competing with the road haulier on equal terms. The North Western Railway has set up in conjunction with a local firm of road hauliers a joint stock company with the Chief Commercial Manager of the Railway as the Chairman of the Board of Directors, and the road services have been arranged so as to provide services at times when the railway itself cannot easily provide them, so that there is no break in the schedule in the twenty-four hours. This joint enterprise is working very

well. The introduction of "Agreed Charges" whereby traffic is held to rail for a period by the railway offering a flat rate for all the traffic based on a fixed charge per ton, irrespective of the distance of haulage, has produced very good results on the B.B. & C.I. Railway which was faced with the problem of combating coastwise country craft competition, which could afford to carry for next to nothing during the off fishing season. Development of air conditioning in railway travel has stimulated passenger traffic, but in a country like India, where the majority of people travel in the lower classes, other improvement in the travelling facilities to lower class passengers, will have a beneficial effect. The same can be said of the development of insulated, refrigerated or registered express and container transport for goods. Most of these innovations have been introduced by Indian railways in different parts of the country. It is however necessary that by undertaking a more elaborate publicity campaign they should be brought before the commercial community, and thus enable their benefits to be more widely appreciated.

Some of the measures, the railways might usefully consider to promote contact with the road undertakings for their mutual benefit, are to encourage, where possible, the bus services to use railway stations as their termini. This will easily enhance the goodwill between the railways and the omnibus people, and act as a good advertisement for the railways. Introducing a system of interavailability of omnibus and railways tickets, besides being advantageous to the public, is also beneficial to the railways, where traffic is sparse and is mainly on the road and takes away the edge from road-rail competition. Adjusting rail and omnibus timings so as to improve connectional services and the provision of special road and rail combined facilities may be put into practice with advantage. 'Publicising' omnibus timings in railway time tables, and the road industry reciprocating the courtesy, the erection of "bus stop" signs on railways premises and the displaying of selected road information at stations contribute largely in the promotion of harmonious working. A system of establishing road and rail charges for the same journey giving such a margin of difference that will neutralise the disability of the railway, where they suffer in the matter of accessibility of stations, or frequency of service, may produce encouraging results. Unremunerative branch lines may be closed and the transport needs of the locality met by agreement with the omnibus undertakings. The possibility of free conveyance of passengers by agreement with omnibus owners to railway termini where these are away from the towns' centres may be explored.

The lines on which future policy in regard to the co-ordination of transport may be based are firstly for the State to insist that the road haulage industry is organised on the lines of the railways, so that the two modes of transport can negotiate on an equal footing, and share alike the benefits of any co-ordination schemes. Road rates are as unstabilised in application as they are simple in structure. Legislation calculated to bring them more into line with railway rates, without introducing undue complications, is essential. The hours of work, wages, regulations, etc., must be made to apply in equal measure to both forms of haulage. The "Undue Preference" and "Common Carrier" clauses which are intended to safeguard the

public must also be made to apply to road rates. The publication of road operation statistics on the same lines as railway statistics are issued is very necessary to enable the public to know what is happening inside the industry, and any big profits accruing to the industry must be passed on to the users in the form of rate relief, etc. The setting up of the Transport Advisory Council and the Standing Committee for Roads is a step in the right direction.

The setting up of an organisation under the joint auspices of the road and railway undertakings entrusted with the task of collecting, analysing and collating all relevant information in regard to problems of common interest to the two industries is certainly worth serious consideration. This organisation can also serve as a clearing house for any outstanding problems at issue between them and advise when consulted in the matter of individual schemes of co-ordination. Problems for investigation may be also referred to this body.

The progress made in the co-ordination of road-rail transport has been considerable and has yielded very satisfactory results. Much ground still remains to be covered. It, however, the vigour, with which the problem is being tackled, should continue unabated, the day is not far off when a completely co-ordinated scheme of transport services will have been evolved.

C. N. R. RAU.

THE DECCAN TRAP

For half-three hundred years million, bowed down with monstrous weight
Of megalosaurs and dinosaurs and saurs of mountain height—
Our earth did groan in severe strain and cracked the Gondwan land,
When the bridge, which spanned the Vindhyan land and the Afric's southern rand,
Submerged—sundered in shattered blocks—beneath the Arab main
And sought the sheltered abyssal depths of Neptune's dark domain.
The Vindhyan land then belched, in gasps, a lurid lava-melt
Through ripped out clefts and rifts afar, in its pent-up strain-filled belt.
The fiery flows from Vulcan's bowl did blaze a burning red
And with gory glow, from down below, they stained the starry bed.
Those bursts of flows—like geysers' surge—had quiescent intervals,
When algal plants and water ferns found tombs with Physa shells.
These Vulcan's pastes did scald the land for miles half million square
And, laid—in steps—to lofty heights, they built a rocky stair.
Their congealed crust, like lakes of jet, did fill the Vindhyan's lap
And cleft and carved by Time's deft hands, it hails now "Deccan Trap".
Its winding glens, at Konkan's edge—with verdant forests fine—
Do run along for miles on miles, like a mazy Maginot line.
Welled these Traps from Vulcan's pools on the wane of Chalk-age day
Or at dawning stage of Tertiary age, as some maintain to-day,
Is a wordy war which rages now with Earth-Science men of Ind,
Who group themselves in fighting ranks to hurl their fossil find.
Sahni's ferns and Hora's fish and Raos's algal cells,
Are thrust to fore to oust the force of Oldham's mollusc shells.
These fossil folk do fight their feuds with Parker pocket pens
And shed their blood—in Quink liquid—in tome-filled dusty dens.
The world moves on unnerved by this,—the fate of Trap-age fight,
To delve Earth's past and date her deeds are not for vulgar wight;
The Earth revolves unchained by this—the Trap-age tangled knot,
She smiles aloof and shouts aloud, "To me it matters not;
The dawn which spanned the Chalk-age night and the morn of Tertiary days,
A tick it counts in endless time: an inch, in boundless space."

R. R. B.

THE ELECTROSTATIC GENERATOR FOR NUCLEAR DISINTEGRATION

BY

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THE electrostatic generator of the moving belt type first developed by Van de Graaff[1] as a high voltage source and later successfully adapted for use with an accelerating tube by Tuve[2] at Washington and Herb[3] at Wisconsin has proved to be a relatively inexpensive and compact apparatus for the production of high velocity protons or deuterons of 0·5 to 3 M.e.V. energy for nuclear disintegration experiments. The homogeneity in energy of the ions which it can yield to the extent of the fraction of a percent and the accurate control of voltage which it affords have made it particularly valuable in the study of proton-proton scattering[4] which is of considerable theoretical interest and the study of resonance effects at energies corresponding to stationary states of the nuclear system. It is also well suited for the accurate measurement of the thresholds of nuclei for emission of neutrons under proton bombardment as well as of the angular distribution of disintegration products in regard to which the experimental data are meagre and the close study of which will reveal the nature of the interaction of angular momenta of the incident and bombarded particles.

The cyclotron extensively developed,[5] at the University of California and of which there are nearly a dozen operating in different parts of the world at the present time can yield several hundred micro-amperes of positive ions of energies 5 to 15 M.e.V. While this feature makes the cyclotron especially suitable for breaking up heavy nuclei and for producing large quantities of radioactive isotopes of possible therapeutic value, the considerable expense involved in its construction and the variation in ion energy by as much as 10 per cent. offset these advantages. Condenser-rectifier voltage multiplying sets of the type[6] developed by Cockcroft and Walton are used in some laboratories and give a good yield of positive ions at steady voltages. Commercial installations of this type of high voltage source yielding more than 1 M.V. are, however, very expensive. The cascade transformer which has been used effectively at the high voltage laboratory at Pasadena[7] and at Ann Arbor, Michigan[8] has proved useful for large neutron yields and in the study of gamma ray spectra where high intensities are necessary. It suffers from the main disadvantage of inhomogeneity of the ion beam. The steadiness of voltage and relative inexpensiveness combined with the fact that the parts can be easily built and assembled make the electrostatic generator with the accelerating tube unit ideally suited for physical laboratories with limited financial resources. The main features and the recent developments in its technique are set down in this article.

Essentially, the electrostatic generator consists of a spherical or cylindrical metal dome, one to two metres in diameter, supported on a textolite or flanged porcelain insulating support about 10 feet high and raised to a high positive potential by a rapidly moving belt, on which is sprayed electric charge by means of a comb system connected to a 10–20 K.V. transformer-rectifier set. The multiple section ion accelerating tube inside which the vacuum is maintained to less than 10^{-4} mm. of Hg by a set of big size oil diffusion pumps, is supported along the axis of the insulating tower. The hydrogen or deuterium discharge tube used as the source of ions, the gas holder, the generator and transformer-rectifier units for the supply of filament current, anode and probe voltages are all housed inside the dome. The gas flow and potentials are adjusted by conveniently arranged strings operating the controls.

Assuming a breakdown potential for air at ordinary pressure equal to 30,000 volts/cm., the maximum current conveyed by an 18-inch wide belt running at 3,600

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ft./minute and arranged to carry both kinds of charge works out to be 450 micro-amperes. It is found, experimentally, that 75 per cent. of the theoretical current is delivered to the high potential electrode. The voltage is adjusted by the control of the spray voltage or by the use of a moveable "poker" consisting of a set of points placed close to the dome. If the belt system is enclosed in a steel tank filled with compressed air at about 100 lb. wt./sq. in., the available voltage is increased[9] by a factor of 2 to 3. Fig. 1† gives a sketch of the pressure electrostatic generator (1–2 M.V.) built at the Kellogg laboratory of the California Institute of Technology, Pasadena and which has been extensively used for the study of fluorine-proton nuclear reactions. A series of metal rings surrounding the tower serve to define equipotential surfaces inside it and a set of adjustable negative point to plane gaps between adjacent rings produce corona current down the ring system and helps to regulate the voltage on the ion tube as well as the different electrodes (20 to 50 in number) constituting the electron lens system of the accelerating tube. Ample room is available inside the ring system for the insulating supports, belts and accelerating tube. Adverse stray currents arising from insulator leakage, corona from rough spots and discharges in the tube make it necessary to have an adjustable corona current across the ring system. It is found[10] that the maximum current which can be drawn from a point to plane corona before breakdown occurs is about 200 micro-amperes. The focussing of the ion beam is controlled chiefly by the potential adjustment of the first few electrodes of the electrostatic lens system. The theory of focussing has been worked out in considerable detail.[11] A focal spot of 3 to 4 mm. diameter with an ion

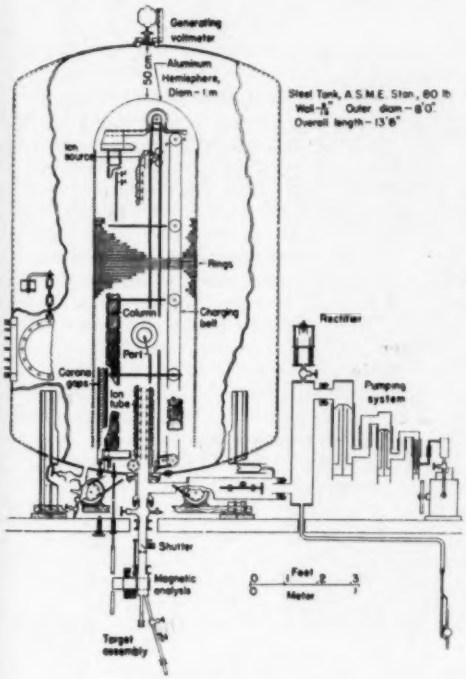

FIG. 1

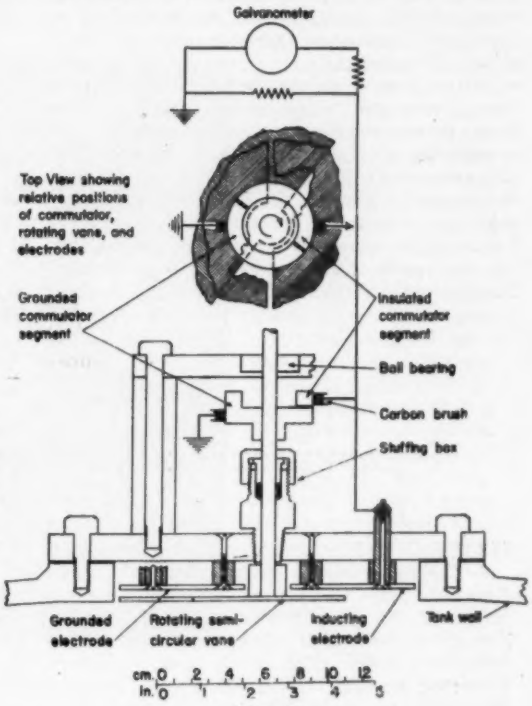

FIG. 2

† We are indebted to Professors Lauritsen and Fowler of the California Institute of Technology for permission to reproduce Figs. 1 and 2.

current of 10 micro-amperes can be obtained with a well-designed ion source, which may be of the hot filament, low voltage or the capillary arc type. The ion beam is separated into its mass spectrum by an electromagnet.

Since concentric electrodes surrounding the charged dome give rise to a more uniform gradient and since high pressure air withstands higher gradients in shorter gaps the use of concentric electrodes increases the spark-over voltage. The available voltage in the latest type of pressure generator housed in a tank (20 ft. × 5½ ft.) at Wisconsin[12] is found to increase from 2·6 to 3·5 M.V., using an arrangement of concentric electrodes.

The voltage is generally measured by means of a generating voltmeter.[13] In one type, the alternating current generated by a spinning disc is measured by a sensitive galvanometer after rectification by a commutator. Fig. 2 gives a sketch of the arrangement used with the generator at Pasadena. Calibration is usually performed using the 440 K.V. peak of gamma ray resonance of the lithium-proton reaction. The sharpness of the proton induced neutron emission reactions indicates that they also may be useful for calibration in high voltage work.[14]

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MANUFACTURE OF DRUGS FROM INDIGENOUS RESOURCES

"BORIC acid for the Medical Stores Department, hitherto obtained from England, may shortly be manufactured in India. It is proposed to purchase crude borax, imported from Tibet, and arrange for the manufacture of the boric acid. Another imported article, tablets Magnesii Sulphas 40 grains, is being manufactured by one of the Medical Stores Depots.

"Peptone powder, used as a culture medium, has hitherto been obtained from England. It is now manufactured in India. A sample has been tested by the Military Laboratories and found to be a suitable substitute for the imported article. Accordingly the article has been transferred to the list of indigenous articles." It may be added that Mr. B. N. Sastry and his colleagues, working at the Indian Institute of Science, have perfected a process for the manufacture of peptone from fibrin by subjecting the material to the action of integrally pure papain.

SIR SHANTI SWARUP BHATNAGAR, Kt., O.B.E., D.Sc., F.Inst.P., F.I.C.

WE have pleasure in offering SIR SHANTI SWARUP BHATNAGAR, our heartiest felicitations on the Knighthood recently conferred on him. He is one of the most distinguished scientists in the country, who assumed the appointment of Director of Scientific and Industrial Research last year.

Professor Bhatnagar is well known for his researches on surface tension, emulsions and other branches of colloidal chemistry. Besides these he has worked in almost every branch of physical chemistry, but his most important work relates to magneto-chemistry, a subject which has come into prominence in recent years. Professor Bhatnagar and his pupils have contributed a very large number of important papers on the subject. His work has found reference in all the important books on the subject and constitutes the major bulk of two monographs on the subject of Emulsions and Emulsifications by Dr. Clayton of the British Association Committee for Colloidal Research. The Bhatnagar-Mathur Interference Balance devised by Professor Bhatnagar is a very sensitive instrument for measuring the magnetic susceptibility of substances, and its manufacture has been taken up by the famous London firm of Messrs. Adam Hilger, Ltd.

Professor Bhatnagar's brilliant work in the domain of colloids was mainly responsible for his association with the Oil Industry in the Punjab. The Attock Oil Co., Ltd., were finding difficulties in the drilling of their wells. Due to the close proximity of the drilling range they were finding that the mud used in drilling was coagulated and refused to flow. The foreign experts had not met with this difficulty anywhere before and though the problem was referred to several experts in Europe and America, no satisfactory solution was forthcoming. They then approached Dr. Bhatnagar for his help. Within six months his experiments were completed and the measures suggested by him were found to be very useful by the Company's experts.

Messrs. Steel Brothers and Co., Ltd., were quick to realise the important advantages that they stood to gain by association with research. Several personal offers were made to Professor Bhatnagar, but he turned all these down and insisted on everything being done under the auspices of the Punjab University. The result was the inauguration in 1934 of the scheme of Petroleum Technology Research sponsored by Messrs. Steel Bros. & Co., at a cost of Rs. 1¼ lakhs to be spent in 5 years in the first instance. The scheme has since been extended to 10 years at a total cost of Rs. 4 lakhs.

Within the short period that has elapsed since the inauguration of the scheme Prof. Bhatnagar has completed several important investigations as a result of which Messrs. Steel Brothers have taken out several patents. Perhaps the most important of these is the one relating to the increase in the luminosity of kerosine oil. As a result of the process worked out by Prof. Bhatnagar it has been possible to increase the height to which the kerosine flame can be raised without giving out smoke to nearly three times the usual height at a cost of a fraction of an anna per gallon.

The other important process relates to the treatment to be given to paraffin wax and

vegetable oils to prevent the development of rancidity. The importance of this process to India will be realized when it is mentioned that 90 per cent. of the world's supply of paraffin wax comes from India and Burma. The process will be of great benefit to all the industries which utilize these articles especially those where the products are required for human consumption or cosmetic purposes. Messrs. The Tata Oil Mills Co., Ltd., have acquired the rights of utilizing this discovery so far as it relates to vegetable oils from Messrs. Steel Brothers.

These and other important researches of Dr. Bhatnagar have made the Indian industrialists realize the importance of research to industry and while at Lahore Professor Bhatnagar had in his hands a number of problems from Indian industrialists like Lala Shri Ram of the Delhi Cloth Mills, for whom Dr. Bhatnagar has already patented a process for producing a soft and lustrous cloth from material hitherto regarded waste; The Lahore Electric Supply Co., who are erecting a plant for the manufacture of white lead; The Tata Oil Mills Co., Ltd., and the famous Birla Brothers of Calcutta. The grants made by these industrialists were being spent in maintaining scholars and meeting the cost of their work.

In the exalted position which he now occupies, he enjoys the unstinted support of his scientific colleagues and the confidence of the Government of India. His opportunities for promoting and consolidating the industrial expansion and economic prosperity of this great country are almost unique, and judging by the manner in which he has been initiating measures for the advancement of both by organising scientific researches in all branches of applied knowledge, we believe that India is already treading the high road to industrial and economic greatness. How soon it will be reached must necessarily depend upon the policy of the Government of India.

SIR RAM NATH CHOPRA, Kt., C.I.E., M.A., Sc.D. (Cantab.), F.N.I., F.R.A.S.B., F.S.M.F., M.P.S. (Hon.) (Lond.), Brvt.-Col.*

THE distinction of Knighthood conferred on DR. RAM NATH CHOPRA has given great satisfaction to his friends, and to the numerous felicitations, which he has already received, we add our own, which though late, are most cordial. His name is held in great respect by the medical profession in India to whose prestige and reputation he has added the fresh lustre of an impressive record of scientific researches of far-reaching importance. Like Sir Shanti Swarup Bhatnagar, Sir Ram Nath Chopra comes from the Punjab.

Even in his early days in the colleges, Sir Ram Nath showed a strong predisposition for conducting original investigations, and the subject in which he was most interested at the time, and whose whole complexion his later discoveries embellished, was pharmacology. While working in the laboratory of the late Professor W. E. Dixon, he produced a thesis on "The Action of Drugs on Ciliary Movement" on the merits of which the young Ram Nath Chopra received the Doctorate Degree in Medicine of the London University. When in 1921, he joined the School of Tropical Medicine as Professor of Pharmacology and Physician to the Carmichael Hospital for Tropical Diseases, Dr. Chopra had served in East Africa and later worked with the British expeditionary force in Afghanistan. Dr. Chopra's work soon laid the foundation of a brilliant school of research in Indian pharmacology, and the contributions from him and his colleagues form a glittering memorial to the institution and constitute an inspiring chapter in the evolutionary history of the Western medical science in India.

With the able collaboration of Prof. Sudhamoy Ghosh and his assistants, a large amount of work on the botanical, pharmacological and therapeutic aspects of Indian varieties of known plants in pharmacopœia has been carried out. This has given us a very valuable knowledge regarding the possibilities of cultivation and economic exploitation of such plants as Ephedra, Belladonna, Aconitum, Artemesia, etc.

The research work on the action of the

* This note is based on a brilliant article written by Rao Bahadur Dr. T. S. Tirumurthi on the occasion of the honour of Knighthood conferred on Sir Ram Nath Chopra.

indigenous drugs of India is one of far-reaching importance. Though no epoch-making discoveries have been made, this inquiry has shown that only a limited number of the remedies deserve the reputation they have earned as cures. The field of research in this domain is a vast one and much is yet to be done, as Col. Chopra himself has said so often. A herbarium representing two-thirds of the total species of known medicinal and poisonous plants occurring in India has been established in Calcutta, and a monograph on 'Poisonous plants of India' is now ready for publication.

Perhaps the most valuable and well-known of Chopra's work was his report as the Chairman of the Drugs Enquiry Committee (1930–31). This report will remain as the best and most authoritative and outstanding publication on the subject of the "Control and standardisation of drugs in the Indian market". The report of the Committee drew attention to the complete lack of control over the trade in drugs and chemicals in this country, and suggested legislation for this purpose. The Drugs Act (1940) was the result of this work and the consistent agitation carried on since then. Even before the Government decided to impose standards for drugs, Chopra was primarily instrumental in establishing the Biochemical Standardisation Laboratory in the All-India Institute of Hygiene.

Col. Chopra was elected a Fellow of practically all the scientific bodies and educational organisations in India including the Royal Asiatic Society of Bengal, the University of Calcutta, the State Medical Faculty of Bengal, the National Institute of Sciences of India, and the National Academy of Sciences. In 1925 he was elected President of the Medical and Veterinary Research Section of the Indian Science Congress, and again in 1938 the President of the Physiology Section during its Jubilee Session. In recognition of his services, he was conferred the honour of C.I.E. in 1933. He was appointed Honorary Physician to His Majesty the King in 1935, and was promoted to the rank of a Brevet-Colonel. International recognition of his work has not also been slow to come. In 1937, the Cambridge University admitted him to the Degree of Doctor of Science, a very high distinction, and the Barclay Memorial Medal of the Royal Asiatic Society was awarded to him in 1938. The same year he was elected a Fellow of the Royal College of Physicians of London and also an Honorary Fellow of the American Society for Pharmacology and experimental Therapeutics. The latter recognition is a very coveted one, in view of the fact that there are only three other Honorary Fellows of this Society—Prof. Hans Meyor of Vienna, Prof. Straub of Munich, and Sir Henry Dale of London,—all three internationally-known pharmacologists. In 1939, he was made a Fellow of the Belgian Society for Tropical Medicine, and he received a congratulatory message from the President of the German Pharmacological Society.

Though officially superannuated Sir Ram Nath Chopra is practically as alert and active as he was when he entered service and we wish him many happy years of notable research in the special field of medicine, which he has adorned by unremitting labours and by penetrating insight.

SIR C. V. RAMAN, F.R.S., N.L.

AT a recent meeting of the Board of Managers of the Franklin Institute of the State of Pennsylvania, it was voted unanimously to award the **Franklin Medal** to SIR CHANDRASEKHARA VENKATARAMAN, *"in recognition of his many brilliant contributions to physical science and of his leadership in the renaissance of scientific work and scientific education that has occurred in India during the last thirty years"*.

The Franklin Medal is the highest award in the power of the Institute to bestow. It was established by Samuell Insull in 1915, and has been awarded for signal and eminent service in science. Arrhenius, Bragg, Dewar, Edison, Einstein, Lorentz, Marconi, Michelson, Planck, Richards, Rutherford, Thomson, Weston, Whitman, Wright and Zeeman are among the distinguished recipients.

Well over a hundred young men—mathematicians, physicists, chemists, and geologists—have had their training in research under Raman. The publications issued from Raman's Laboratory both at Calcutta and at Bangalore cover a dozen branches of physics, and include well over six hundred titles of papers. A bibliography of these publications would not however convey a sufficient idea of the influence—direct and indirect—which Raman has exercised on the promotion of science in India. Many of his past pupils occupy important positions all over the country as Professors, Readers or Lecturers in the Universities, or as members of the Government scientific services. His personality has exerted a profound influence on the growth of an active scientific atmosphere in India during the last thirty years.

We beg to offer to Sir C. V. Raman, our congratulations on this great distinction.

MANUFACTURE OF SCIENTIFIC STORES

THE Principal Information Officer, Government of India has announced that the Supply Department is examining a list of scientific stores to determine which of the items therein could be manufactured in this country. This commendable step will be welcomed by every one interested in the manufacture of scientific instruments and industrial equipment in this country. We have, no doubt, that there are a number of firms who are interested in the manufacture of a few of these and other allied items, but there is a vast number of instruments for which the country is still dependent upon foreign import. It is hoped that the Government of India will give the necessary protection to the scientific instruments industry in the country, so that the manufacturers who may take up this industry under the stress of war may be enabled to establish this key industry on a sound and profitable basis, even after the return of peace.

DR. HOMI J. BHABHA, F.R.S.

INDIAN Scientists, and Physicists in particular, will learn with great joy that DR. HOMI J. BHABHA has been honoured by a Fellowship of the Royal Society of London. That this should have come at such an early age and on the first nomination is a fitting recognition of his brilliant researches. The conferment of this distinction on two Indian Physicists during the year is a clear indication of the momentum that the study of pure science for its own sake has acquired in this country and the international recognition it has earned for itself.

Born in the year 1909 Dr. Bhabha took his early University education at the Royal Institute of Science, Bombay, and at 17 he joined Gonville and Caius College, Cambridge. After taking the Mathematical Tripos Part I, he changed over to engineering and took the Mechanical Sciences Tripos in 1930. But the engineer soon turned Physicist, and like Prof. Dirac he took to mathematical physics. He got his early training under Profs. Dirac and N. F. Mott at Cambridge and later under Prof. W. Pauli at Zurich. He made useful contacts with great scientists on the Continent by working in turn with Prof. Fermi at Rome, Prof. Krammers at Utrecht and Prof. Niels Bhor at Copenhagen.

From 1935 onwards Dr. Bhabha lectured at the University of Cambridge till the outbreak of War cut short his career there. Since his return to India he has spent most of his time at Bangalore, where he has continued his researches at the Indian Institute of Science and given lectures on theoretical physics.

His presence in India is largely responsible for the great rise in interest in the study of cosmic radiation in which he is an authority.

His later years at Cambridge were very fruitful to Dr. Bhabha from the view-point of scientific research. His first important work was a paper with Heitler on the cascade theory of cosmic ray showers which appeared in the *Proceedings of the Royal Society* in 1937. In the following year he published two other important papers. The first showed the existence of a new fundamental particle in the penetrating component of cosmic radiation and the second gave the quantum theory of this particle, which has now been called the meson. The first paper also explained the production of showers by the penetrating component through the agency of collision electrons, by a process which is now called after Bhabha. There were nevertheless serious difficulties in the quantum theory of mesons and during the last two years Dr. Bhabha has given solutions of these difficulties in three papers. Two of the difficulties were connected with the scattering of mesons, which as predicted by the old theory was in disagreement with observations. Dr. Bhabha's solution of this difficulty predicts two new fundamental particles, and points the way to future experiments.

Dr. Bhabha's most serious hobby when he is away from physics is painting, and apart from his pictures, he has designed and painted the Stage Decor of several Operas and plays which were produced at Cambridge. Such a rare combination of artistic and scientific talent is certainly very refreshing to any one who comes in contact with him. It is with sure confidence that we can expect greater successes from this scientist.

VIKRAM SARABHAI.

THE SEVERE MAGNETIC STORM OF MARCH 1, 1941

BY

M. R. RANGASWAMI

(Colaba Observatory, Bombay)

A SEVERE magnetic storm was recorded by the magnetographs at the Alibag magnetic observatory at 03^h 58^m GMT, on Saturday, the 1st March 1941, with a characteristic "sudden commencement" in all the three elements. H rose instantaneously by 42 gammas and westerly D by 1·4 minutes of arc. There was a simultaneous fall of 15 gammas in Z. When attention is confined to the H magnetogram it is seen that the force fluctuated with small-period oscillations till 05^h 08^m whereafter it rose rapidly by 132 gammas in thirty minutes reaching its maximum at 05^h 38^m. Then a fall with oscillations followed till 07^h 06^m after which time once again a rapid rise of 91 gammas occurred in fifteen minutes. 07^h 21^m marked the beginning of a rapid fall which continued till 09^h 27^m. The fall in H during this interval of a little over two hours amounts to 354 gammas. After this a gradual rise in H began with oscillations till 13^h 13^m when once again a fall and that, a very rapid one, commenced. In this case H decreased by 334 gammas in 46 minutes and was still falling, when unfortunately the light speck went off the scale at 13^h 59^m, and the H record was lost for about 96 minutes. At 15^h 35^m the light speck was brought within the margin of the photographic paper by a controlling deflector magnet which was strong enough to shift the trace by 276 gammas. The

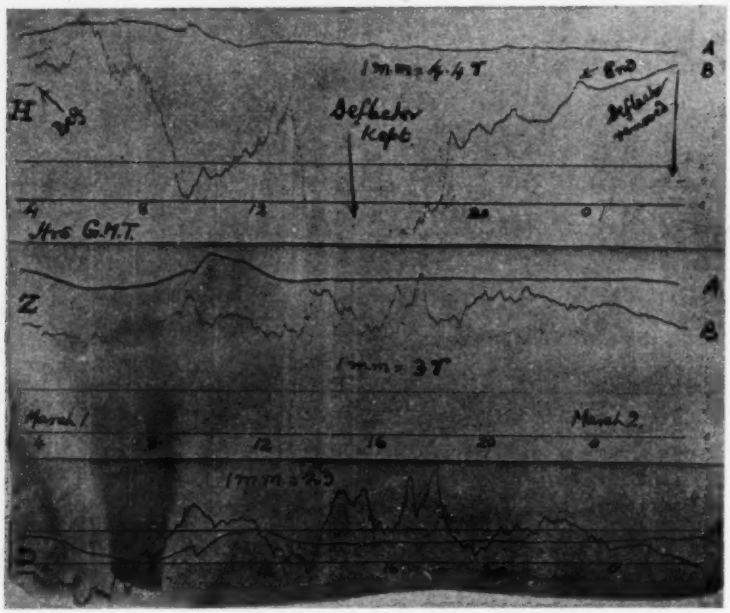

FIG. 1

H, *Z* and *D* magnetograms recorded at the Alibag Observatory
A—Records for the day previous to the storm
B—Records for the day of the storm (1st March 1941)

presence of the deflector, however, could not prevent the loss of record for any appreciable time. Hardly four minutes elapsed, and the speck was once again below the margin of the paper due to a further large decrease in the value of H. This loss of record could not be prevented as there was no provision to keep the deflector magnet at a much nearer distance. Arrangements are now being made to prevent such loss in the future. The speck reappeared on the photogram at $17^h\ 48^m$ whereafter the oscillations began to die gradually with the slow rise in the force. The storm practically ended by $23^h{\cdot}5$ on March 1, but the value of H was still about 265 gammas below its pre-storm value. From the nature of the trend of the trace at minimum time it appears that the H range during this storm has exceeded 785 gammas by a moderately large amount. The D and Z ranges during this storm were 16 minutes and 130 gammas respectively. The magnetograms of this storm together with those for the day previous to the storm have been reproduced in the figure for comparison.

PREVENTION OF GHEE ADULTERATION

AT an informal conference of ghee packers convened by the Agricultural Marketing Adviser to the Government of India and held in Delhi on February 19 under the presidentship of Mr. P. M. Kharegat, C.I.E., I.C.S., Vice-Chairman of the Imperial Council of Agricultural Research, the adulteration of ghee with *Vanaspathi* and the rapid rise in the price of ghee due to the abnormal demand for the military department, were discussed.

The following steps, among others, were recommended to check the adulteration of ghee:—

(i) Extension of the Food Adulteration Laws to the whole of a province or state instead of their scope being limited to certain municipal or town areas.

(ii) Delegation of power to Marketing Officers to carry out inspection under the Food Adulteration Acts.

(iii) Sale of *Vanaspathi* in sealed and labelled tins.

The conference also decided that the Federation of Agmark Ghee Packers might consider the desirability of approaching the Supply Department with the proposal that Agmark ghee might be purchased for future army requirements.

It was revealed at the conference that on account of high acidity in ghee during summer months, very large quantities of ghee cannot be marked with the Agmark label, particularly in the United Provinces and Bihar. It was, therefore, agreed that the maximum percentage of acidity of general grade be raised from 2·5 per cent. to 3 per cent. It was further agreed to have the same chemical standards for special and general grades except in regard to acidity.

On the question of sub-packing stations, there was general agreement that authorised packers might be allowed to have sub-packing stations provided satisfactory arrangements could be made for the testing of raw ghee at each of these sub-stations.

REVIEWS

An Introduction to the Kinetic Theory of Gases. By Sir James Jeans. (Cambridge University Press), 1940. Pp. 311. Price 15*sh.* net.

The credit of having presented in English for the first time the Kinetic Theory of Gases 'upon as exact a mathematical basis as possible' goes to Sir James Jeans. The first edition of his *The Dynamical Theory of Gases* appeared in 1904, and many students of Physics as also many mathematicians drew their sustenance from that book in spite of the stiff treatment of the subject. Other editions which appeared in 1916, 1921 and 1925 included more material such as the treatment of the Quantum theory. The present edition is less costly and is within the reach of the average serious student of the subject. This may perhaps be due to the size of the book being much smaller than before. It may look less imposing, but surely it is less forbidding, and is certainly more inviting to students of science. Evidently the appearance of many special treatises on the Quantum theory in recent times has induced Sir James Jeans to effect a thorough change in the scope of the present book, and there is hardly any reference to the Quantum theory. Even so, other subjects of interest such as Aerostatics are omitted.

To a very large extent the contents of the earlier editions are retained here often in the same words. New material has been included under the heads of the experimental tests of Maxwell's Law of Distribution of Velocities, and Perrin's work on the Brownian Movement. But it is surprising that Sir James Jeans has not touched on any of the more recent and the fascinating developments of the subject such as Low Pressure Phenomena, Fluctuations and the Electric and Magnetic properties of gases. There must have been very strong reasons for not including them, but we confess to a feeling of disappointment. His remarkable way of writing raises expectations in us; but he seems to have decided that they need not be gratified. The master mind which has given such an admirable treatment of the famous theorem of persistence of velocities could throw a flood of light on these newer phases of the subject much to the advantage of the student of physics and physical chemistry.

In this connection one recalls to mind the concluding sentences in the *Mathematical Theory of Electricity and Magnetism* by the same author. Referring to the newer concepts introduced by the Quantum theory he writes "..... the limiting case provides a bridge between the old mechanics and the new; on one side of the bridge the classical electrodynamics holds undisputed sway, but as we cross the bridge and advance into the territory on the other side, the additional restrictions imposed by the Quantum dynamics become ever more important, until finally they may be considered to govern the whole situation. The exploration of the territory on the far side of the bridge will provide work for a new generation of mathematical physicists; the present work attempts only to bring the reader as far as the bridge, and to make clear to him that if he crosses it he must expect to find different conditions prevailing on the other side". In the domain of Kinetic Theory of Gases we are now led by Sir James Jeans only as far as a similar bridge though his guiding hand in the new territory would have been invaluable and unique.

The Cambridge Press has as usual got up the publication quite nicely though it is hard to understand how some minor typographical errors have crept in, as for instance on page 160 duo/dx is printed instead of duo/dz, and this error occurs twice in rapid succession on the same page.

P. SRINIVASA ROW.

Mathematics of Statistics. By John F. Kenney. Part I. 1940. Pp. x + 248. Price 12*sh.* 6*d.*

Mathematics of Statistics. By John F. Kenney. Part II. (Chapman & Hall, Ltd., London), 1940. Pp. ix + 202. Price 11*sh.*

The author states that his object has been "to write an up-to-date text which will serve to prepare the student for the really mathematical part of the theory of statistics". He has succeeded in producing a useful compilation which will serve as a standard text-book for statistical teaching. Important aspects of the subject have been covered in an adequate manner on the whole;

and obscure and unfamiliar ideas have been clearly explained.

The book is divided into two parts. The first part deals with what may be called descriptive methods, and the second part with sampling theory. This relegation of the theory of distribution to the very end has resulted in some lack of definiteness both in notation and ideas in the earlier part. But this may be unavoidable in an elementary text-book; and the wise course may be to leave the beginner to get his ideas about statistical inference clear after he has become familiar with the more descriptive portions of the subject.

Part I starts with an introductory chapter in which the scope of the science of statistics is treated in a concise but lucid manner, with some interesting observations on the relation between mathematics and statistics. Chapter I deals with frequency distribution on familiar lines. The distinction between class limits and class boundaries is clearly explained, but the difficulty of boundary points is avoided by taking the class boundary to a higher place of decimal than that used in the primary material. The treatment of 'graphical representation' in the second chapter is rather meagre, and can be amplified with advantage.

Chapter III deals with averages of various kinds such as the arithmetic, geometric and harmonic means, modes, medians, etc., in the usual way on purely algebraic lines. In every case the results are given in the form of abstract theorems. This may be convenient for a purely formal development of the subject, but it is not clear how far this is either necessary or desirable for teaching purposes.

The fourth chapter on moments gives a useful summary of algebraic results including an elementary description of Sheppard's correction. Some reference might have been made at this stage to associated symmetric functions like semi-invariants and cumulants which are being increasingly used in theoretical investigations. It is worth noting that new symbols, namely, a_3, and a_4 for the Pearsonian $\sqrt{\beta_1}$ and β_2, are introduced presumably to avoid confusion with the so-called β-coefficients in correlational analysis which are extensively used in the United States. The β_1 and β_2 notation is, however, so deeply ingrained in Pearsonian literature that a change of notation is likely to be merely confusing. If the Pearsonian approach is to be given up, the simplest plan would be to adopt directly the cumulant and k and kappa notation of R. A. Fisher.

Chapter V gives a general description of measures of dispersion. Skewness and kurtosis are explained briefly in Chapter VI together with a fuller treatment of the normal curve and its important properties. The next Chapter VII deals with curve fitting in an elementary manner. Time series and exponential trends and ratio charts are also briefly discussed together with a useful description of the Gompertz curve in this chapter. The Pearson family of curves requires fuller treatment; and other well-known systems deserve mention. Perhaps the best plan would have been to discuss systems of curves in greater detail in Chapter VII, and devote a new chapter to the discussion of time series and other curves.

Chapter VIII is taken up with the elements of correlation theory and associated topics such as the coefficient of alienation. There is a general description of the normal bivariate frequency surface with an elementary treatment of non-linear regression and Pearsonian η^2, and a discussion of tests of linearity on older lines which is not adequate.

Part I is complete by itself. Special features are the large number of exercises at the end of each chapter, and the review questions and problems at the end of the book. There are two appendices giving the ordinates and areas of the normal curve to five places of decimal, and the common logarithms of numbers to five decimal places.

Part II deals with more recent analytic developments, and gives in a convenient form a useful summary of the essentials of the theory of sampling distributions. Chapter I starts with elementary topics of probability. No attempt is made to go into logical foundations. Thus the ratio of frequencies is accepted as the basis of the definition of probability, and the concept of the limit of the ratio is introduced without any discussion. This is followed by the usual theorems in permutations and combinations and a fairly full treatment of the binomial distribution. The approximation to the binomial with the normal curve is discussed in considerable detail. The simple sampling of attribute is then considered, and the probable error is introduced. The discussion of standard errors and correlation of errors in class frequencies is particularly

worth noting. The chapter concludes with a discussion of the Poisson exponential.

Chapter II supplies a convenient summary of results in integral calculus and γ and β functions which are constantly required in statistical theory. Chapter III deals with the Pearson system of curves. The connexion between the Pearson family and problems of sampling from urns is clearly explained. This is followed by a number of more advanced results relating to the normal curve with a brief treatment of the Gram-Charlier series. The joint distribution of two variables and the normal correlation surface form the subject-matter of Chapter IV. Important results are obtained with the help of calculus, and relevant formulæ for tetrachloric correlation are given at the end. Chapter V gives a general treatment of multiple and partial correlation together with a large number of results.

Fundamentals of sampling theory relating to the mean are given in Chapter VI. The treatment is broadly algebraic based on the method of mathematical expectations. The reproductive property of normal law is pointed out and emphasised; and certain algebraic results for moments of non-normal distribution are quoted without proof. This is followed by Tchebycheff's inequality and the law of large numbers. This forms the background for introducing the concept of "null hypothesis", tests of significance, and the significance of a difference in proportions.

The theory of small or exact sampling distribution is discussed in Chapter VII; and the ψ^2 distribution and statistical inference in Chapter VIII. The seventh chapter opens with an algebraic calculation of the expected value of the variance, which naturally leads on to a discussion of unbiassed estimates and the concept of degrees of freedom. This is followed by a discussion of Student's *t-distribution* by analytic methods. Fisher's method of geometrical representation is next explained and used to obtain the distributions of the standard deviation and variance, and of Fisher's *t*. The structure of analysis of variance is explained in the case of a twofold table as well as its use in testing linear regression. The multinominal law is used as the starting point for the discussion of the ψ^2 distribution.

The second part of Chapter VIII starts with a brief introduction regarding induction and Bayes' theorem on usual lines. This is followed by a concise treatment of fiducial limits with standard formulæ for the mean, difference between two means, and variance.

The last three chapters probably form the most valuable part of the book. Our only complaint is that the author has not gone far enough. The mathematics used is not quite elementary, and the student who understands thus far can be readily trusted with some of the more advanced work in the sampling distributions, and may be taken deeper into modern theories of estimation and of testing of hypothesis.

The appendix in Part II gives five per cent. and one per cent. points for the distribution of the ratio of variance, and also the χ^2-probability scale reproduced from R. A. Fisher's Table.

A large number of exercises and review problems are given in each part. References to published papers and hints for additional reading form a valuable feature. The book abounds in quotations of varying length and importance; these are always enjoyable and often stimulating. In many ways the book is an improvement on textbooks of similar scope and aim.

P. C. MAHALANOBIS.

General Physics. By W. L. Whiteley, B.Sc. (Lond.). (The University Tutorial Press, Ltd.), 1940. Pp. viii + 590. Price 7*sh.* 6*d.*

This book represents a course of physics upto the S.S.L.C. standard with emphasis on the practical and technical applications illustrating physical principles. The mathematics required for perusing the book is very limited, only sparing use having been made of simple Algebra and Trigonometry. Illustrative figures and diagrams are plentiful, and the principles underlying many technical applications are briefly explained as often as possible. Illustrative examples are neatly worked out and a large collection of problems is distributed throughout the book. But on account of the large ground covered, the explanations are sometimes too meagre and sketchy. With so many everyday appliances, based on physical principles, which the citizen meets in common life, every educated person ought to possess at least as much knowledge of physics as is contained in this book. We feel that the book is particularly suited for students taking up Diploma courses in technical subjects in which a knowledge of physics is essential.

T. S. S.

Technique of Grassland Experimentation in Scandinavia and Finland. (Herbage Publication Series, *Bull. No.* 28. Published by the Imperial Bureau of Pastures and Forage Crops, Aberystwyth), 1940. Price 2*sh.* 6*d.*

The Technique of Grassland Experimentation is considered under two heads: (1) Quantitative measurement of grass production; and (2) Stock-grazing trials. These aspects are dealt with clearly in seven articles by various workers. The salient points brought out in the bulletin are:

(1) Instead of using permanent, fenced areas, which are expensive, movable "control cages" made from boards and barbed wire, 4×4 m. in size are employed. This method has proved advantageous especially in testing the yield of pasture leys in harvesting hay for winter fodder.

(2) The technique of stock grazing is of great value on large areas which are suitable for large-scale experiments.

(3) Climatic and soil conditions have a great effect upon the results. This point is of importance to India, where divergent climatic and soil conditions are encountered. Experiments on a large scale should be undertaken in various parts of the country in order to obtain results of practical value.

(4) For botanical analyses, the Hult-Serander method is employed. This gives an idea of the covering of each species. The method does not appear to differ from the method of Braun-Blanquet in any essential point. In the experience of the reviewer, this method cannot be applied with any accuracy for Indian grasslands where the number of grass species and weeds is great.

The Bulletin will prove to be a valuable guide to scientists in India engaged on studies relating to our grasslands.

F. R. B.

The Biochemistry of Symbiotic Nitrogen Fixation. By Perry W. Wilson. (The University of Wisconsin Press, Madison), 1940. Pp. xiv + 291. Price $3.50.

Nitrogen is one of the most interesting and important elements intimately concerned in the economy of life processes. It is considered to be an inert element in the sense that it does not enter into combination with other gases like oxygen and hydrogen at ordinary temperatures and atmospheric pressure, and cannot, therefore, be 'fixed' without having recourse to high temperatures and pressures. In nature, however, this fixation takes place in the soil and in plants at ordinary temperatures through the agency of micro-organisms. The fixation that takes place in the bodies of plants is called symbiotic fixation, as it is brought about by micro-organisms to the mutual advantage of the plants and the micro-organisms. This process of fixation is most evident in leguminous plants.

The chemistry of symbiotic nitrogen fixation is a fascinating subject for study and is relatively an unexplored field. In recent years there have been published several papers dealing with the fixation of nitrogen by bacteria and plants,—the biochemistry of bacteria, the mechanism of fixation and the enzyme systems connected therewith. These contributions to our knowledge of symbiotic nitrogen fixation are many and scattered in literature. The author has collected and reviewed these several papers in the publication under review. The book contains eleven chapters. The first chapter contains a discussion on the nitrogen economy of man and nature; the second is a survey of the work on leguminous plants; the next seven chapters deal with the bio-chemistry of the fixation process, while the last two chapters are devoted to a discussion on the practical and theoretical aspects of the subject.

The book is well written and neatly printed, and makes a useful addition to the library on the subject. B. V. N.

Catalogue of Indian Insects—Part 25. Thysanoptera. By T. V. Ramakrishna Iyer and V. Margabandhu. (Manager of Publications, Delhi), 1940. Pp. 64 + viii. Price Rs. 2–2–0 or 3*sh.* 9*d.*

Till recently very little work on any aspect of this comparatively generalised order of insects in India, had been done. A systematic treatment of this group had been a long-felt want among Indian Entomologists and the authors who have now brought out this volume, deserve their warmest thanks.

The *Catalogue* includes 232 species distributed among 94 genera. The classification adopted by Karny and Watson, has been closely followed by the authors in the arrangement of the different species.

THE RAMAN EFFECT

Scattering of Light and the Raman Effect. By S. Bhagavantam. (Andhra University, Waltair), 1940. Pp. 333 + x; 2 plates and 41 figures. Rs. 15 net.

IT is an old saying that 'good wine needs no bush', and on reading Professor Bhagavantam's volume my first impression is that the work needs no recommendation to the discerning physicist. It commends itself in three ways. Firstly there is the intrinsic interest and great importance of the subject-matter, with which every physicist nowadays must have at least a nodding acquaintance. Secondly there is the obvious need of a book which gives a view of the whole subject, in sufficient detail to be of use to the advanced worker. Thirdly there is the name of Prof. Bhagavantam—a sufficient recommendation in itself. It is well known that Prof. Bhagavantam has himself taken a great part in many of the advances in this field during the past dozen years, and no one is better qualified than he to give a connected account of it.

My second impression is of the great weight of knowledge which lies behind this volume. The scattering of light was at one time one of the by-paths of Physics, interesting in a way but leading nowhere in particular. It has now become a main thoroughfare, a highway which connects many seemingly unrelated subjects. The papers which have been published on the Raman effect alone, since its discovery in 1928, must run into thousands; and for any one person to be aware of all this progress, and acquainted with much of its detail, is itself a considerable achievement. Prof. Bhagavantam shows a scholarly knowledge of a very wide range of published work, and, as far as one who is not an expert in this field is able to judge, he gives a balanced account of the whole. The book is by no means confined to the contributions made in India, important as those contributions have been. Further, the theoretical interpretation of the phenomena is given its due place, and not subordinated to the purely experimental part. Indeed the experimentalist may possibly find some of the chapters rather strong meat; such as XI and XII, which involve some knowledge of tensors and the theory of groups. To extract the nourishment which these chapters contain requires a good mathematical digestion. But even those of us to whom such chapters will inevitably be something of a struggle will welcome them for the development of a theoretical understanding of the phenomena is surely no less important than the phenomena themselves.

My third impression, which only the reading of such a connected account can give, is of the rapidity with which Nature has revealed her secrets in this field. The colour of the sky, and of the sea, must have been one of the earliest natural phenomena to impress itself on the mind of man. But the phenomena which have been longest known have often proved most difficult to understand; lightning and permanent magnetism are obvious examples. No sooner had the classical theory, in the hands of Rayleigh and others, taught us why the sky is blue, than the new developments began. Any comparison of our present knowledge with that of even twenty years ago emphasises the astonishing progress since the time when, with a little theory and a modicum of experimental results, a few pages would have sufficed to give a reasonable account of the whole subject.

The first nine chapters of this book are concerned with ordinary scattering. After a short historical introduction there follows some fairly simple classical theory, and formulæ are deduced which give the intensity and depolarisation of the light scattered by molecules. Chapter IV is a careful account of experimental methods and a comparison of the results with what may be deduced on the simple theory. One may commend Prof. Bhagavantam's wisdom in putting the experimental methods together in this chapter, and again in chapter XV for the Raman effect, so that the experimentalist finds no difficulty in going straight to what he wants. The numerous tables of experimental results which are to be found throughout the book are also to be commended. In chapter V the theory of scattering by dense media is given, followed by another chapter of results. Then come liquid mixtures, and finally a discussion of optical anisotropy and birefringence, and the connection with molecular structure.

Those readers who are chiefly interested in the Raman effect may turn straight to

chapter X. This is an excellent chapter, giving a sort of initial survey of the Raman effect and including several beautiful photographs of Raman spectra. Then comes the theory—more advanced this time—and even the author himself suggests that some of this may judiciously be omitted at a first reading. Some may prefer to take chapter XV, an excellent account of experimental technique, immediately after chapter X. The self-contained character of these chapters makes this possible.

The last three chapters are also of great interest. They deal with the Raman effect as a means for the elucidation of chemical problems. They presuppose, of course, a knowledge of much of the earlier part of the book, but are very readable and largely non-mathematical. They contain a wealth of experimental material. The book ends with seven appendices on mathematical topics.

In a book of this kind there is not much ground for criticism. The experts may differ, as they always do, about the choice of material, but in so vast a field it is clear that selection is inevitable. The ordinary reader would probably have valued a select bibliography, even though the author explains that such have been given elsewhere. The references are actually fairly numerous, but they occur somewhat sporadically in footnotes. An index of the chemical compounds mentioned would increase the value of the book as a work of reference. Compared with the general excellence of the book, these criticisms are of a minor kind. The English throughout is clear and direct, and scarcely anything more serious than an occasional slip in punctuation has been noticed. The printing is in a large clear type on good paper, and there are remarkably few misprints. One curious feature is that each chapter begins on a right-hand page, even though (as at the end of chapter X) this involves leaving practically two whole pages blank.

Every physicist whose work is connected with the scattering of light will want a copy of Prof. Bhagavantam's book on his table, and it should find a place in every Physics library. If the chemists can also be induced to buy a copy, so much the better, for no branch of Physics throws more light on the problems of Chemistry than this. It is on all accounts a book to be warmly welcomed.

H. J. TAYLOR.

REGIME FLOW IN INCOHERENT ALLUVIUM*

DESIGN of non-silting canal sections was first attempted by Mr. Kennedy; based on data collected from Upper Bari Doab Canal he derived the empirical equation $V_0 = 0{\cdot}84D^{0{\cdot}64}$ where V_0 is the critical mean velocity at which a canal neither silts nor scours and D is its depth over a nearly horizontal bed. In 1919, Lindley put forth a relation of bed width to depth of $B = 3{\cdot}80D^{1{\cdot}61}$. Several formulæ of the form $V = C\,D^n$ were subsequently introduced satisfying a particular set of conditions with varying values for C and n. According to these formulæ, a given discharge and silt charge uniquely determined depth width, and slope of a regime channel.

Mr. Gerald Lacey's work* on regime flow in incoherent alluvium is of great value to irrigation engineers. In 1930, he proposed the equation $P = 2{\cdot}668Q^{1/2}$ connecting the wetted perimeter of a stable channel with its discharge. Starting with the idea that in a silt transporting channel a constant discharge tends to transport a fixed "regime" silt charge, Lacey concludes that a constant discharge, carrying silt of a given grade and flowing in an alluvial plain of the same grade tends eventually to assume a gradient solely determined by the discharge and silt grade, and that the mean velocity, hydraulic mean depth and wetted perimeter tend to unique determination.

From an analysis of the data from the Upper Doab Canals and Madras-Godaveri Western Delta, Lacey derives the relation $V = c\,R^{1/2} = K^1\,m\,R^{1/2} = K\,f^{1/2}\,R^{1/2}$ where f is a silt factor, K a numerical constant, $m = \frac{V}{V_0}$ critical velocity ratio, and R is the hydraulic mean radius. Lacey concludes that $\frac{V}{R^{1/2}} = C$ is a function of the grade of alluvial material transported when the channel is active,

* *Regime Flow in Incoherent Alluvium*. By Gerald Lacey. (Central Board of Irrigation Publication No. 20.), 1940 p. 65.

the material is incoherent, and there is a balance between silting and scouring, the value of c at all times indicating the degree of turbulence and eddying motion in the water. From the Lindley Lower Chenab Branch data Lacey derives the relations $R^{1/2}S = c'$ and $c = 16\ c'^{1/3}$ and from these he gets $V = 16R^{2/3}S^{1/3}$ as the general regime equation.

Lacey further states that the rugosity of a channel or the coefficient of a regime channel flowing in alluvium depends on the average size of the materials of the boundary and introduces what he calls an absolute rugosity coefficient N_a based solely on the average size and density of the transported and moving bed material. $V = 16R^{2/3}S^{1/3}$ written in the form $V = 64\left(\frac{R}{V}\right)^{1/2}\sqrt{RS}$ makes the Chezy coefficient $C = 64\left(\frac{R}{V}\right)^{1/2}$. When V is replaced by $V = K\,m\,R^{1/2}$, C becomes equal to $\frac{64R^{1/4}}{K^{1/2}m^{1/2}}$ which can be written as $\frac{R^{1/4}}{N_a}$ in metric units or as $\frac{1{\cdot}3458}{N_a}\,R^{1/4}$ in foot units. Kennedy takes the Upper Bari Doab Canal silt with a critical velocity ratio of unity as standard silt. Lacey writes $N_a = {\cdot}0225m^{1/2}$ and takes the standard grade of silt as having $N_a = {\cdot}0225$ when the H.M.D. is one metre. Equating $\frac{64}{K^{1/2}m^{1/2}}$ to $\frac{1{\cdot}3458}{N_a}$ gives K a value of 1·145. To obviate the difficulty experienced in assigning values to the rugosity coefficient, Lacey gives N_a a value appropriate to the bed material and the equation is written as $V = \frac{1{\cdot}3458}{N_a}R^{3/4}(S - s)^{1/2}$ where s is a suitable deduction made from the gross slope to account for the errors in the determination of correct slope and H.M.D. and for the shock encountered due to bends, irregularities and condition of the channel.

From Kennedy's data, Lacey derives the relation $V = 1{\cdot}17R^{1/2}$ and from Kennedy, Madras, and Lindley data he gets $Af^2 = 3{\cdot}8V^5$ where A is the area of the cross-section. From these two equations he gets $P = 2{\cdot}668Q^{1/2}$, or $P = (2{\cdot}668)^2\,RV = 7{\cdot}12RV$. If K is put equal to 1·1547, K^2 becomes $\frac{4}{3}$ and $f = \frac{3}{4}\frac{V^2}{R}$ and $c = 16{\cdot}04557c'^{1/3}$ and $S = {\cdot}0003727f^{3/2}\,R^{-1/2}$ or $\cdot000391\,\frac{f^{5/3}}{q^{1/3}}$ where $q = RV$, or $\cdot000542\,\frac{f^{5/3}}{Q^{1/6}}$.

Regime Equations

Lacey

$P = 2{\cdot}668Q^{1/2}$

$V = 1{\cdot}155f^{1/2}R^{1/2}$

$R = {\cdot}472\left(\frac{Q}{f}\right)^{1/3}$

$S = {\cdot}000542\,\frac{f^{5/3}}{Q^{1/6}}$

Punjab Research Institute

$P = 2{\cdot}800Q^{1/2}$

$V = 1{\cdot}120R^{1/2} = {\cdot}767Q^{1/6}$

$R = {\cdot}470Q^{1/2}$

$S = {\cdot}00209\,\frac{m^{{\cdot}86}}{Q^{{\cdot}21}}$ (m-diameter of silt particle in mm.)

The two slope equations show that the silt factor and silt grade take the place of a rugosity coefficient and are interrelated; if the power of m is taken to be ·833 it would make the silt factor vary as the square root of the mean diameter of the silt particle.

Crump found on analysis that in stable silt transporting canals the critical velocity ratio is an inverse function of the Kutter's rugosity coefficient. Any rugosity coefficient depends on the grade of bed silt. Lacey on plotting the values of f and m from the Punjab data finds that any correlation between m and f must be of an inverse character.

In perfect regime channels with wetted perimeter consisting of incoherent silt, grade of bed silt can be correlated with turbulence as measured by $\frac{V^2}{R}$ and under such circumstances, turbulence is also a true silt factor. In non-regime channels or channels approaching regime but not free from shock and the Crump effect, the grade of bed silt is a function of gross turbulence in the channel; the gross turbulence, the result of mean forward velocity, agitation of water brought about by shock, and destruction of shock energy, is also measured by $\frac{V^2}{R'}$ where R' is the altered value of the H.M.D. due to the existence of shock at the section. $\frac{V^2}{R'}$

the measure of gross turbulence is a true silt factor, R′ being greater than R where positive shock is encountered and less than R under exceptional circumstances when there may be negative shock due to irregularities in the channel taking the form of smooth portions of stiff fine clay banks and also possibly smooth rigid patches of the bed; in the latter case with the bed silt fine almost coherent there is no limit to the value assumed by $\frac{V^2}{R'}$; such a channel would have rigid boundaries as a limit and would fall beyond the class of channels under discussion.

Lacey suggests that the silt factor in a channel, free from shock, varies as the square root of the bed silt grade and that f_r will be equal to $km_r^{1/2}$ for silts of equal coherence, suffix r indicating regime conditions. When there is shock the measured values of m and f determine shock and the products $m_r^{1/2}f_r$, $m^{1/2}f$, $m'^{1/2}f'$ are all equal; the silt factor far from varying directly as the square root of the bed silt diameter, varies inversely as the square root. In the Punjab data, shock is so important a factor that variations in silt grade are often traceable to this source. $f_r = m^{1/2}f$, and $f_r = km_r^{1/}$ yield $m^{5/6} = \left(\frac{f_r}{f}\right)^{5/3}\left(\frac{f_r}{k}\right)^{5/3}$.

The 'Bose-Malhotra' slope equation $S = \cdot 00209\frac{m^{\cdot 86}}{Q^{\cdot 21}}$ being an empirical relation partially compensates for shock. Shock in such channels transporting silt, perfectly incoherent or of constant coherence, will be indicated by a departure from regime slope and a corresponding departure from normal bed silt. Lacey modifies this relation to $S_b' \propto \frac{m^{5/6}}{q^{1/3}}$ and finds from the Punjab data, that $S_b' = \cdot 0010002\frac{m^{5/6}}{q^{1/3}}$ which can be written as $\frac{\cdot 0010002}{k^{5/3}} f_r^{5/3}\frac{\left(\frac{f_r}{f}\right)^{5/3}}{q^{1/3}}$ where k should be equal to 1·1775 to suit the Punjab data. S then becomes $\cdot 000385 f_r^{5/3}\frac{\left(\frac{f_r}{f}\right)^{5/3}}{q^{1/3}}$. When $k = 1\cdot 760$ S becomes $\cdot 000391\, f_r^{5/3}\frac{\left(\frac{f_r}{f}\right)^{5/3}}{q^{1/3}}$ and this becomes identical with Lacey's slope equation $S = \cdot 000391\frac{f^{5/3}}{q^{1/3}}$ when there is no shock.

Lacey finds that the equation fits the Punjab data well and concludes that it is applicable to regime channels transporting sandy silt of standard coherence, thus introducing a coherence factor for the majority of the Punjab observations as unity. For silts of the same degree of coherence $f_r = k'm_r^{1/2}$ where $\frac{k'}{1\cdot 76}$ is the coherence factor for the silt and the modified equation of Bose is written as $S_b' = \cdot 0010002\left(\frac{k'}{k}\right)^{5/3}\frac{m^{5/6}}{q^{1/3}}$ where $\frac{k'}{k}$ is a coherence factor and $S = \cdot 000391\,(k')^{5/3}\frac{m^{5/6}}{q^{1/3}}$ when k is taken equal to 1·760.

In the Punjab data there are five discordant channels of small discharge, for these channels it is found from the tabulated values that ·001311 replaces ·0010002 thus making $(K')^{5/3}$ ·000391 equal to ·001311 giving k' a value of 2·07, and the coherence factor a value 1·175; and in the case of the five large discordant channels k' becomes 1·894 and the coherence factor 1·075. In the case of the small channels the silt factor is relatively high and the bed silt grade low, but high slopes are required in spite of the silt being fine as a result of increased internal friction of fine silt due to its coherence. In the case of the five large channels assumption of a high silt charge increasing coherence renders them concordant.

Bose's modified equation $S = \cdot 0010002\frac{m^{5/6}}{q^{1/3}}$ applies equally well whether shock is present or not; shock is implicit in the equation and silt is of uniform coherence with a silt factor constant $k = 1\cdot 76$. When no shock is present Lacey's equation $S = \cdot 000391\frac{f^{5/3}}{q^{1/3}}$ is applicable whether the coherence varies or not, coherence being implicit in this relation.

To eliminate the effects of variations of kinematic viscosity, Dr. Malhotra gets from Lacey's equations for silt factor, the relation

$V \propto \left(\frac{R}{m}\right)^{1/2} (gRS)^{1/2} S^{1/2}$, in this relation kinematic viscosity being implicit as $\frac{R}{m}$ is a function of the temperature of water. Lacey writes this in the form $\frac{V}{V^*} \propto \left(\frac{RS}{m}\right)^{1/2}$ (where $V^* \propto \sqrt{gRS}$) to express regime flow in incoherent alluvium.

Mr. Gerald Lacey's work is a valuable contribution to the understanding of regime flow in alluvium and is a stimulus to further research on the subject.

C. GOPALAKRISHNAN.

SOME PRACTICAL RESULTS OF SUGARCANE RESEARCH IN INDIA

THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH represents perhaps the most important outcome from the recommendations of the Royal Commission on Agriculture in India (1926) and the renaissance of the Indian Sugar Industry is possibly the most tangible achievement of that Body. The sugarcane position in India at the time of the founding of the Imperial Council of Agricultural Research in 1929 was such as to enable that Council to recommend to Government certain very important steps both by way of tariff protection to the industry and the proper organisation of sugarcane research in India for rehabilitating it. The Council acted both quickly and effectively.

The result is seen in India passing from the position of a major sugar importing country to the present one of surplus production and consequent search for export facilities. Certain of the recent troubles from the sugarcane belt of North India reported in the Press and from the platform are attributable to this very rapid but somewhat ill-planned development of our sugar industry during the last decade. The renaissance of the Industry has shown, however, that Indian capital is by no means shy when suitable avenues are open to it.

In the field of cane research a chain of experimental stations covering all the important cane areas has come into being, financed wholly or partly from the Council's funds and we have before us a publication* of the Council summarising practical results from such work upto and inclusive of 1937–38. Though the results now available are almost three years old, a brief resume of the salient features is here attempted as likely to be of considerable general interest in view of the stress now being rightly laid on the industrial development of our country as a necessary precedent to full development in other directions, economical, social and even political. The publication before us is of such practical utility that the public will be entitled to look forward to similar periodical publications in the future.

The publication includes a bird's eye picture of the history of sugarcanes in our country with a brief description of the Indian indigenous canes which were once in cultivation over the bulk of sugarcane India (mainly sub-tropical). While a low acre yield appears to be their characteristic feature, a fair amount of resistance to the rather difficult conditions of sub-tropical India has been their saving quality. This latter quality would appear to have been partly incorporated in the new Coimbatore productions "Co. Canes" through a somewhat complicated scheme of hybridization.

Brief notes are given of the characteristics of the more important of the new canes. Though the bulk of such are Coimbatore productions which are apparently the most widely cultivated, a few seedling canes from Mysore and foreign countries are also included. The utility of importations from foreign countries like Barbados, Java and Mauritius, would appear to have been mainly in tropical India like Madras and Bombay and also parts of Bengal. A brief indication is also given of types which at the time were considered promising and we gather that certain of these are steadily gaining ground as anticipated.

The report opens with a picture of the recent change in the varietal position

* *Miscellaneous Bulletin* No. 34 of the I.C.A.R., Manager of Publications, 1940, pp. 41, price Rs 1-8-0 or 2*sh.* 3*d.*

province by province. It is seen that in certain provinces like the United Provinces and Bihar, the new Coimbatore productions have covered 90 per cent. or over of the cane areas. In the Punjab over 30 per cent. of the area is yet under an indigenous cane which possesses certain special features that suit the extremely unfavourable conditions for cane growing in that province. The position of varieties in provinces of lesser importance, like Bengal, Bombay, Madras and Assam, is also reviewed. In the Mysore State about 50 per cent. of the area is said to be occupied by a cane HM. 320 bred from a Research Station in the State. This cane as well as a few others of the same origin have spread to parts of Bombay as well.

Section 3 covers, what may be termed, the agricultural aspect of the sugarcane industry and is full of useful informations on various aspects of cane culture, such as, planting, interculture, rotation, manuring and irrigation.

This section starts with a record of the increased yields obtained as a result of the introduction of improved canes coupled with improvements in agricultural practices. The results show in some cases an increase of 50 per cent. and over in the sub-tropical sugarcane belt and in large-scale plantation conditions. The breeding of tropical types was initiated at Coimbatore a decade and a half after its founding, the breeding for sub-tropical conditions occupying its entire attention before this period. This was because of the comparatively larger area (over 80 per cent.) in the sub-tropical belt. We learn that the results of breeding from the tropics are quite equal to that originally recorded in the sub-tropical regions.

When the chain of sugarcane stations was started in the beginning of the last decade, definite improved methods of planting and manuring were available as a result of the work of the various departments of agriculture in India. Three such well-known methods were (1) Shahjhanpur, (2) Pusa, and (3) Manjri methods. The Testing Stations, after carefully experimenting with these methods, were able to record important improvements on them both by way of increasing tonnages and lessening costs of cultivation. Every sugarcane planter, large or small, would do well to study these improvements with the object of utilising them, if possible, to his conditions. Germination is important in cane growing and the report records useful advances both in optimum seed rate and treatment of planting material.

The manurial experiments which include both time and quantity, as well as relative efficiency of different mixtures, have great practical value. Whereas in certain parts of tropical India 150 lbs. of nitrogen together with green manuring is found to be the optimum, the quantity in terms of nitrogen values is appreciably less for sub-tropical India where the corresponding figure is sometimes as low as 60 lbs. The difference between sub-tropical and tropical conditions is further brought out in the case of phosphoric acid application which, while giving some response in Bombay, shows little effect in the Punjab or the United Provinces. It is interesting to be told that dressings of potash definitely increases the rind hardness of cane in the United Provinces which shows that it might be possible to play on the constitution of a plant like the sugarcane through careful soil treatment.

Besides the above, there are other useful results recorded in the publication. Marked advantage has resulted from the introduction of the green manure crop into the rotation both in Bombay and in the United Provinces. The irrigation experiments have tried to find out the minimum quantity on which canes could be grown without affecting gur qualities. The publication finishes with the results of investigation on soil types, pests and diseases, and the various factors affecting cane growth. The publication is priced Rs. 1–8–0 and one wishes it were priced distinctly lower economising in the wrapper and binding. Certain similar publications from the U.S.A. are distributed to agriculturists free or at nominal cost.

"SUGARCANE GROWER".

OBITUARIES

SIR FREDERIC BANTING

BY the death of SIR FREDERIC BANTING, the famous discoverer of Insulin, in a plane crash in Goose Bay, Newfoundland, a great personality has been lost to the world of Science. It is reported that this most unfortunate incident occurred while he was flying, with three others on a very important scientific mission to Britain. The New York correspondent of the '*News Chronicle*' has given further details of this mission. Dr. Banting, it appears, was flying to Britain to demonstrate a new gas defence method he had perfected in collaboration with chemists and physiologists of the University of Toronto. It is to be regretted that he has not lived to see the benefits of his labour in this respect.

Frederic Banting was born at Alliston, Ontario, on the 14th November 1891, and had his medical education at the University of Toronto. Even before he obtained the M.D. Degree in the year 1922, he was lecturing on Physiology at the Western Ontario University at London and thereafter on Pharmacology at Toronto University. Within a period of two years of his graduation, he was appointed Professor of Medicine at the very early age of 32 years.

The researches on the role of pancreas in carbohydrate metabolism attracted the attention of Dr. Banting even while he was a student for the M.D. Degree. In the year 1921 and 1922, Banting and Best succeeded in preparing physiologically active extracts of the pancreas. These extracts were found to inhibit glycosuria and hyperglycemia in depancreatized animals and to alleviate the symptoms of diabetes mellitus in human beings. From a critical study of the existing literature it became apparent to Dr. Banting that in order to prepare active extracts from the pancreas, it was necessary to circumvent the destructive action of the pancreatic enzymes on the hormone. It had been shown previously that the Acinar enzyme secreting cells degenerate more rapidly than the hormone secreting islands of langerhans. The brilliant idea of ligating the pancreatic ducts of dogs and keeping the animals for a period of several weeks to allow the Acinar tissue of the pancreas to degenerate, is entirely credited to Dr. Banting although the work was done in the laboratory of Dr. Macleod, the co-discoverer of Insulin, who was at that time the Professor of Physiology at the University of Toronto. The potential possibility of such a procedure was fully taken advantage of and the brilliant efforts of Banting, Best, Collip and Macleod in this direction, culminated in the successful achievement of the goal. A record of the development of these investigations is given by Banting.[1,2] Patents for the manufacture of Insulin were taken out by the Insulin Committee of the University of Toronto, to whom Dr. Banting and his co-workers made over the process discovered by them. Since this epoch-making discovery, Dr. Banting continued his investigations on the nature and effect of Insulin which is of very great importance in the treatment of diabetes.

The discovery of Insulin, its isolation and therapy is one of the greatest landmarks in modern medicine. This is regarded as one of the biggest contributions of the twentieth century for the alleviation of human suffering. Honours and awards came to Dr. Banting freely from Scientific Bodies and Universities from all over the world. He was awarded the Gold Medal and the Reeve Prize of Toronto University in 1922. In 1925, the Canadian parliament voted him an annuity for life, while in the same year, Toronto University established an amply endowed Institute for medical research known as the Banting Institute. In the year 1923, he was awarded the Nobel Prize for the discovery of Insulin jointly with Macleod.

I had the pleasure of meeting Sir Frederic Banting for the first time in September 1939, at Toronto, where I had been working as a Vincent Massey scholar. I felt at once that he was somewhat out of the ordinary run of scientific men. He was known as a great figure in science, but he could have been equally great at almost anything else.

Immediately after the declaration of War, he was appointed the head of medical research for War, by the Canadian Government. Under his inspiring leadership, a

[1] *Canad. Med. A. J.*, 1926, **16**, 221.
[2] *Edinburg Med. J.*, 1929, **1**, 1.

method of preparing concentrated serum and its application in war wounds was perfected. Simultaneously the investigations on antidotes for poison gas were being carried out in the various scientific laboratories in the University. Dr. Banting must have scored a success in his spectacular work on the new gas defence method. This work is as great as his discovery of Insulin. The new formula has been made known to others and it will therefore be available. Mr. Mackenzie, President of the Canadian National Research Council, is reported to have made the statement that the story of this discovery is a great one and will be told after the war.

Besides being a sympathetic teacher, Dr. Banting was a delightful colleague. All those who have had the pleasure of association with him will cherish his memory with affection and admiration.

N. K. IYENGAR.

SIR SHAH MOHAMMAD SULAIMAN

THE news of Sir Shah Sulaiman's passing away came as a shock to the whole country. But perhaps no one was shocked more than those (of whom the present writer is one) who had enjoyed his overwhelming hospitality just before he fell ill, and who had seen him only three weeks ago taking the most active part in the annual session of the National Academy of Sciences, India, of which he was the President. It is heart-rending to think that he has been snatched away when his mental faculties were at their zenith, and when he was making valuable contributions to human knowledge. His countrymen and others would mourn his irreparable loss for a long time to come!!

Shah Mohammad Sulaiman was born in Jaunpur in 1886. After an exceptionally brilliant school and college career at Jaunpore and at Allahabad, he proceeded to England in 1906 with a State scholarship and joined Christchurch College, Cambridge. He took the Mathematical Tripos in 1909, and the Law Tripos in 1910. That he was no ordinary student pursuing only the prescribed course, is proved by the fact that he had pondered deeply over the prevalent theories of matter and light, and had made notes of his "ideas about radions" which he developed into a coherent theory twenty-five years later. He was also called to the Bar in 1909, and obtained the LL.D. of Dublin in 1910. Returning to India, he joined the Allahabad Bar, and had such a distinguished record that he was offered a seat on the Bench at the unusually early age of 34. In 1929 he was appointed the first Indian Chief Justice of the Allahabad High Court when still comparatively young. When the Federal Court of India was created in 1937, his was an obvious choice for one of the two posts. His work there elicited praise and admiration not only from his colleagues but also from the celebrated English jurist, J. H. Morgan. His was a meteoric rise, and it is not difficult to imagine what further heights he would have attained if he had been spared a little longer. He had an equally phenomenal career as a Scientist. He appeared suddenly and most unexpectedly on the scientific horizon, shone with an ever-increasing lustre for an all too brief period, gained some recognition, and disappeared just as suddenly.

In spite of his being engrossed in the heavy duties of a lawyer and a judge, he took a keen interest in educational matters, and did a great deal for the education of his people. He was a member of the court and academic committees of several Universities and presided over various educational conferences of an all-India character. He was invited to deliver the Convocation addresses of the Agra, Aligarh, Dacca and Osmania Universities. For a number of years he was Vice-Chancellor of the Muslim University, and discharged the exacting duties of his office up to the time of his death. Though his enthusiasm sometimes carried him too far in trying to model the working of the Institution according to his ideas, the whole nation owes him a heavy debt of gratitude for the sacrifice of an immense amount of his time and energy in the cause of education which was so dear to his heart.

All this by no means exhausted his capacities. His energy and vitality knew no bounds. He was a versatile reader, and his library contains one of the finest private collections of manuscripts and books to be found in the country. The present writer had an opportunity of seeing in his possession about a hundred rare Arabic and Persian manuscripts on mathematical and

scientific subjects. He was thinking of editing the most important among these and of having them published. We hope that his family would see their way to having his dream realised. It would be a fitting tribute to his glorious memory.

For the last several years in the midst of his multifarious activities he still found time to do creative scientific work, and he had gradually acquired a more intimate knowledge of modern theoretical physics than many a professional physicist. He had never lost the enthusiasm for this science acquired in his Cambridge days, but it was only in 1933, a quarter of a century later, that he could find time to develop his ideas. Though in this long absence from the field of science he had lost touch with modern developments, it should be remarked to his great credit that he made up the deficiencies very soon. There is a world of difference between his early papers, which were rather amateurish, and his later ones which bear the stamp of a recognised scientist. Such examples are indeed rare in the history of science.

To be able to appreciate his work properly, one must keep in mind the fundamental difference between two schools of thought in the philosophy of to-day. According to the classical school "the purpose of science is to explain the unfamiliar experience in terms of the familiar one by means of the visual images or models". The modern school believes that the explanation of natural phenomena on the atomic scale and the cosmic scale cannot be forthcoming in terms of crude mechanical models of the nineteenth century, and that mathematics is the only tool to deal with the abstract concepts of modern physics. Sulaiman belonged to the classical group, and condemned in strong terms the modern tendency of "accepting such artificial mathematical devices not capable of any real physical significance" and of making ourselves "slaves of mere mathematical symbols". He characterised the current philosophy of knowledge as a "counsel of despair" and an "attitude of defeatism". He believed that "the explanation of the physical world by means of models is important not only for science itself, but also for the general progress of mankind". He was convinced that such an explanation is attainable. Unfortunately for him, the majority of theoretical physicists to-day belong to the second group. This is one of the reasons why his ideas did not find general acceptance among scientific circles, though a few workers here and there agreed with him.

He was a rebel against all authority, and against the "blind faith in the new methods" required of a modern student. He had set himself the task of making a "complete exposure of the various inconsistencies underlying the modern theories", in the hope of inducing the younger generation of scientists "to examine for themselves the full implication of modern postulates". It is quite possible that his open revolt may help to bring about a modern renaissance, just as the revolt against the authority of Aristotle and the Greeks brought about a renaissance of the seventeenth century.

His method was the method of systematic doubt, and like Descartes he began by doubting every axiom on which modern conceptions are based. He questioned the appropriateness of almost every hypothesis about matter and radiation put forward by Newton, Huygens, Maxwell, Planck, Einstein, Bohr, de Broglie, Heisenberg, Schrödinger and Dirac, and rejected them all one by one. But he was not unaware that it is easier to make destructive criticism than to offer constructive suggestions. He submitted alternatives for the two great theories in modern physics, *viz.*, the relativity theory and the quantum theory.

He criticised Newton for assuming (1) that gravitation had an instantaneous effect, thus implying that its velocity was infinite, (2) that the same law of gravitation applied to two bodies whether they were at rest or in relative motion. He criticised Einstein for (1) denying the absoluteness of space, time and motion, (2) making the velocity of light absolute, independent of the motion of observers, (3) giving to space curvature and other properties, (4) making space finite and yet making its finite limit incapable of being attained, (5) denying reality to force and making it a property of space, (6) for introducing a cosmical force of repulsion with the consequent expansion of the universe. He was of opinion that Einstein's "apparently unconvincing assumptions" would not have been accepted if the relativistic equations were not believed to have been confirmed by observation in three remarkable instances, *viz.*, (*a*) the deflecti n of light from a star when passing close to the sun, (*b*) the displacement of the fraunhofer lines, and (*c*) the advance of the

perihelion of Mercury. Sulaiman challenged these alleged verifications. He quoted recent observational data to show that in each of these three cases there was a glaring discrepancy between Einstein's value and the observational value. He therefore found no justification for accepting "the extraordinary hypotheses on which relativity is founded". Against this, he tried to show that "the ordinary principles of dynamics when applied to moving bodies, themselves yield modified forms of equations which, as a first approximation, reduce themselves to Newton's forms; and as a second approximation to Einstein's form" thus restoring Newtonian Mechanics "to the eminent position it occupied before its dethronement by relativity". He believed that he had succeeded in obtaining such modified equations. This is where the present writer differed from him, and argued with him several times. Obviously, his criticism of the existing theories was to a great extent justified, but it was difficult to see that his own theory was a better substitute, or that his methods were quite acceptable. That, however, is another story.

Sulaiman based his new theory on the assumption that gravitation was an internal action, and not due to any extraneous force acting at a distance. At first he assumed that light consists of material particles called radions which are radiated from surfaces of bodies, and that there are still finer particles called "gravitons" which emanate from the entire mass but are at present beyond the range of our perception. Later on, he gave up this idea of gravitons, and assumed simply that the effect of gravitation is propagated with a finite velocity D, which is nearly constant, and which is equal to the velocity of light. By four different methods he obtained the polar differential equation for the path of a planet, which, he believed, included Newton's and Einstein's equations, and yielded better results than these in the three cases mentioned above. He claimed that neither Newton's nor Einstein's theory can explain an increase of semi-major axis and eccentricity of Venus, Earth and Mars nor a decrease in the case of Mercury and that his own theory not only could explain this, but the sign predicted by his formula agrees with Newcomb's observations, as admitted by Dr. R. Hamilton.

He considered it a crucial test that according to his theory the spectral shift of light from the sun would be $(1+\sin^2\alpha)$ times Einstein's value, where α is the angle between the line of sight and the radius of the sun, giving just double of Einstein's value at the limb. According to *Nature* (1937, 140, 13), Dr. Royd's observation with the correction pointed out by Dr. Evershed shows that "the displacement at the limb was twice the predicted Einstein value". Sulaiman claimed this to be a "cent per cent. confirmation" of his prediction.

He had finally come to adopt the position that even if there are flaws in his physical theory "the law of gravitation

$$-\frac{\mu}{r^2}-\frac{3\mu h^2}{D^2}\frac{1}{r^4}$$

propounded by him, can be taken as an empirical law giving correct values" in the cases mentioned above.

Like J. J. Thomson, Sulaiman was a non-believer in the quantum theory, because, as he believed, it gave rise to a "dilemma in physics", *viz.*, the fact that matter and light could be neither purely corpuscles nor purely waves. To him the idea was philosophically repugnant that they could be both corpuscles and waves. His very last paper, *viz.*, the address delivered at the Delhi Session of the National Academy of Sciences, makes a searching analysis of the whole question, and points out the unreal character of modern physical theories. He sets out to restore reality to nature, and removes the fallacies that there can be any waves without a medium, and that the phenomena of interference and diffraction cannot be explained on any corpuscular hypothesis. As the belief in a medium is demonstrably untenable, he rejects the wave theory altogether and retains only the corpuscular theory of light as well as of matter. But his light-corpuscles are not just the light particles of Newton or the light-quanta of Einstein. For him "light is a binary corpuscle, consisting of one positive and one negative charge, rotating round each other under their mutual force of attraction, the whole system moving forward with high velocity". He has published the mathematical development of this Rotational or Binary Theory as Chapters XIV and XV of his "Mathematical Theory of a New Relativity" published in the various numbers of the *Proceedings of the National Academy of Sciences*, India, between 1934 and 1940. In

these papers he has tried to deduce almost all the fundamental results of modern quantum mechanics. Naturally, it will take some time to analyse his work and find out how far his claims are justified.

His work earned him a considerable reputation, and he was the recipient of several honours. The editors of *Nature* (11th May 1935, p. 797), *Science* (16th and 30th November 1934) and *Science News Letter* (1st December 1934; March 1935) wrote encouraging reviews of his theory, and some scientists of renown made appreciative remarks about it. He was awarded the Honorary Degree of D.Sc., elected the Vice-President of the *Calcutta Mathematical Society*, Fellow of the *National Institute of Sciences*, India, and President of the *National Academy of Sciences*, India.

It remains an acknowledged fact that there is a serious crisis in the foundations of modern physics. Sulaiman's ambition was to formulate a rational and unified theory of physical phenomena. Even if he has not succeeded—and it must be remembered that he did not have much time to develop his ideas—it cannot be denied that he did a great service to modern science in focussing our attention on the glaring anomalies in existing theories!

RAZIUDDIN SIDDIQI.

ADVANCE OF EDUCATION ON THE FRONTIER

THE schools are slowly coming to be accepted as a feature of life in North Waziristan and the village schoolmaster is beginning to be regarded as having other uses besides falsifying the dates of births and deaths.

In North Waziristan education has to contend with the fanatical opposition of hostile elements. In October 1939, they kidnapped an old and devout Muslim, a teacher in the Miranshah middle school, and stabbed him in the back. Unsettled conditions have made the inhabitants reluctant to take responsibility for the protection of school buildings, so that four schools have to be housed in hired buildings at unnecessary expense. The eight primary schools, like the middle school, are in the relatively settled revenue-paying areas in or near the valley of the Tochi river.

The newly re-opened school at Spalga, however, attracts a few Wazirs as well as Daurs. In 1939–40 two thousand rupees were distributed in scholarships. The schools held an athletic meeting at Miranshah followed by an entertainment given by the boys. A large number of outsiders attended and immediately petitioned for a high school. The middle school also gave an amusing play at the New Year celebrations.

In the South Waziristan Agency there are lower middle schools at Kaniguram, Ladha, and Kotkai, and five primary schools. The number of pupils has increased appreciably, and there is a keen demand for educational facilities. In 1939–40 five thousand rupees were sanctioned for scholarships. A lot of boys, chiefly Mahsuds, go to the Church Missionary Society's High School at Dera Ismail Khan where Dr. Iliff is running a boarding-hostel for these tribal pupils. Many of the best families send their sons to this school, where attention is paid chiefly to character-building, and the results being achieved amongst the Mahsuds call to mind the progress made amongst the Kashmiris by Canon Tyndale-Biscoe.

The demand for education in the Malakand Agency far exceeds the facilities available. There is a High School at Thana, a lower middle school at Dargai and fourteen primary schools. In Swat State, there is an anglo-vernacular middle school at Saidu. In Chitral State, the primary school at Chitral has been raised to the middle standard and a large new school building has been constructed. There are eighteen schools in all.

INDIAN SCIENCE CONGRESS, BENARES, 1941

Summaries of Addresses of Presidents of Sections

7

ZOOLOGY

President: PROF. A. SUBBA RAU

SOME ASPECTS OF MAMMALIAN PLACENTATION

HARVEY (1657) regarded the placenta as an organ which elaborated from the maternal blood the food required for the development and growth of the fœtus, while Mayow in 1674 considered that it performed the function of a fœtal lung. The view that the maternal blood circulated through the placenta was put forward by John and William Hunter. We owe to Jenkinson (1913) the view that the placenta is the organ in which the blood vessels of the embryo are brought into intimate anatomical and physiological relation with the spaces in which maternal blood is circulating. Placentation was defined by Otto Grosser (1910) as the intimate junction of the mucosa of the uterus with the chorion for purpose of exchange of material between the mother and the offspring. Professor Hill emphasised that the placenta was a composite structure partly maternal and partly fœtal, the two being either in simple apposition or intimately blended, but in no case with an admixture of fœtal and maternal blood streams. Normal mammalian placenta, in the words of Masoman, is an apposition or fusion of the fœtal membranes to the uterine mucosa for physiological exchange.

The yolk-sac placenta except in the native bear and the wombat is usually of transitory functional significance. The Eutherian mammals have allantoic placenta. The placenta was formerly distinguished as diffuse, multiplex, zonary, cotyledonary or discoidal according to its external appearance. Weber, Huxley and Strahl based their classification on the presumption that in certain forms there was loss of maternal tissue during parturition. Caducous or non-caducous (Weber), deciduate or non-deciduate (Huxley), Placenta vera or semi placenta (Strahl). Assheton divided the Placenta into placenta cumulate and placenta plicate, based on the activity of the trophoblast. Otto Grosser's classification, however, into four types based on the exact relations of the maternal and fœtal tissues has general approval: epithelio-chorialis, *e.g.*, pig; syndesmo-chorialis, *e.g.*, sheep; endothelio-chorialis, *e.g.*, carnivores; hæmo-chorialis, *e.g.*, Rodentia, Insectivora, Cheiroptera, Anthropoid Apes and Man. Some maintain that the epithelio-chorialis type is primitive and the hæmo-chorialis is highly specialised while others regard the latter as the primitive type. Both views have facts to support, but the former view is more probably the correct one. The number of layers of cells that separate the two blood streams progressively decreases from six in epithelio-chorialis to three in hæmo-chorialis. The endothelium of the maternal capillary, the connective tissue around it, the uterine epithelium, the trophoblastic epithelium, the connective tissue of the allantochorion and the endothelium of the fœtal capillary represent the six layers in the epithelio-chorialis type. In the syndesmo type the uterine epithelium is lacking; in the endothelio type the fœtal connective tissue is also lost; and in the hæmochorialis the maternal capillary endothelium disappears in addition to the above two.

In the fallopian tube the fertilized ovum depends on the secretion of the surrounding tissues for its nourishment. In the uterus, till it attaches to the uterine wall, it is nourished by uterine secretions; with the establishment of the placenta, it depends on direct absorption by the trophoblast of the products of the uterine mucous membrane; and with the vascularisation of the allanto-chorion, on the maternal blood.

The proteins are transferred as amino acids to the fœtal blood; the exact nature of the amino-acids has yet to be worked out satisfactorily in the different types of placenta. The glycogen store of the mother is the chief source of carbohydrate for the fœtus. The leucocytes of the maternal part of the placenta seem to play a part in the transference of fat, these loaded with fat migrating into the fœtus. In the human placenta the fats may either pass across the placental barrier to the fœtal blood or may be absorbed by the maternal placenta from its blood stream and passed on to the fœtal blood with or without modification. Further work on the function of the placenta as a judicious regulator of fat supply may promise fruitful results, as the fat content of the placenta is stated to decrease with age. Work on placental enzymes is also needed. Our knowledge of the role of vitamins other than that of "E" is meagre, as also of the mineral metabolism.

The fœtal hæmoglobin differs from that of the mother in the few forms that have been recently examined. The studies of Boor and Hektoen indicate that the carbon monoxide hæmoglobin is species specific. Further, the blood of different animals show both qualitative and quantitative differences in their hæmoglobin. The metabolic needs of the embryo and accordingly the oxygen requirements vary in different species of mammals. The physico-chemical properties of the placental barrier in different groups of mammals with reference to the rate and intensity of exchange of materials await satisfactory solution.

The subject of nutrition of the pregnant mother may well form the subject of serious research in the newly established ante-natal clinics in Indian Maternity Hospitals. The attention of the Nutrition Research Laboratories may also be directed to the study of fœtal nutrition. Indian zoologists may in future turn more and more to experimental methods in their investigations. A co-operative effort by

zoologists, physiologists, specialist medical men, and biochemists is needed in a well-planned study of fœtal nutrition.

S. G. M. R.

3

CHEMISTRY

President: PROF. MATA PRASAD

PHYSICO-CHEMICAL STUDIES OF GELS

THE gels may be broadly classified as organic gels, inorganic gels and inorgano-organic gels, the classification being based upon the nature of the gel-forming material. The organic gels are obtained usually by preparing a hot solution of the material in a suitable solvent and cooling it down until it sets. In some cases, mere heating with a suitable solvent is sufficient to bring about the gel formation. Change of solvent is again helpful in the preparation of certain gels. Amongst the inorgano-organic gels, we have the soap gels studied by McBain and co-workers. It has been shown by the work at the *Royal Institute of Science*, that good, transparent, colourless gels of many soaps could be obtained in pinene; these gels showed syneresis and were found to be heat reversible. Inorganic gels have been produced by (*a*) mixing the constituents of a gel-forming mixture, (*b*) by the addition of electrolytes to a solution and (*c*) by the change of solvent.

The composition of the gel-forming mixture has a profound effect on the properties of the gel formed. This aspect has received considerable attention at the laboratories of the *Royal Institute of Science* and has led to the preparation, in a transparent state, of a number of gels which were originally known only in an opaque or translucent condition.

The kinetics of the formation of gels has been the subject of numerous investigations. The methods of (*a*) Flemming, (*b*) Fells and Furth, (*c*) Hurd and Letteron, and (*d*) Prasad and Hattiangadi, for determining the setting time, are found to yield different values for the same gel-forming mixture. The methods are however, useful for a comparative study. Effect of temperature on the setting time has been investigated by Hurd and co-workers. They are led to consider that the setting of a gel is an activated process. Prasad and co-workers found that heat reversible gels are often associated with a negative heat of activation. The effect of concentrations of reactants, pH, electrolytes and non-electrolytes on the rate of setting has been studied with several gel-forming systems. Prasad and co-workers have contributed considerably to our knowledge in this field. They have followed up the setting process by measurements of viscosity and intensity of transmitted light. The latter technique has now been perfected by Gogate working at the *Royal Institute*. Subbaramiah has followed up the process of gelation by measuring the depolarisation factors, ρ_r, ρ_∞ and ρ_4. His results are in general agreement with the accepted ideas regarding the process of gelation.

Gels exhibit many interesting properties. Certain class of gels become solutions on being mechanically agitated and set into gels again on standing. This phenomenon known as thixotropy has been investigated by several workers. Special mention is to be made of the work of Goodeve and co-workers, who have devised a viscometer which permits of a continuous alteration of the rates of shear. Prasad and co-workers have observed "Zonal" changes of viscosity during the gelation of thixotropic gels.

Systematic work on the elastic properties of inorganic gels has been carried out by Prasad and by Yajnik and co-workers. The vibration of the free gels has been studied by Prasad. The vibration of containers containing set gels has been studied by Holmes and co-workers.

The phenomena of syneresis and swelling or inhibition has been investigated by several workers, as also the drying of jellies.

Considerable amount of work has been done on the sorptive properties of the dried gels. Recent work of K. S. Rao on hysterisis in sorption has established the correctness of the cavity concept proposed by McBain for explaining hysteresis. The cavity idea fully explains the phenomena associated with the scaning of the hysteresis loop as well as the drift and the disappearance of the loop.

The structure of jellies has been investigated by a number of workers. "The fibrillar theory is in harmony with most of the characteristic properties and varied phenomena shown by gels. It explains satisfactorily the elasticity, viscosity, syneresis, swelling, dehydration and hysteresis diffusion and optical and ultramicroscopic phenomena. This theory has the adherence of most of the workers on the subject of gels although it cannot be assumed *prima facie* that all gels have the same architecture."

K. S. GURURAJA DOSS.

4

GEOLOGY

President: DR. M. R. SAHNI

PALAEOGEOGRAPHICAL REVOLUTIONS IN THE INDO-BURMESE REGION AND NEIGHBOURING LANDS

Vindhyan to Devonian

IN his Presidential Address to the Geology Section, Dr. M. R. SAHNI deals with the Palæogeographical Revolutions in the Indo-Burmese Region and neighbouring lands during the Vindhyan to Devonian period. To use his own words, he has attempted to give us "a panoramic review of the sequence of geological events that have moulded the palæogeographical history of the Asiatic continent, and more particularly of the Indo-Burmese

region" during this period. Such a review has naturally to be based almost entirely on a comparative study of the rocks and fossils of this period in different areas—the only basis of exact correlation being the occurrence of identical species of animal or plant fossils in strata of marine or continental origin as the case may be. Whenever there is a difference in the character of the marine faunas of a period between two adjacent areas, the usual tendency is to interpolate a land barrier; but as Dr. Sahni has pointed out, this is not always correct since "variation in the physical conditions such as temperature, depth, relative salinity, direction or strength of ocean currents of intercommunicating marine regions may be just as effective barriers to the migration of marine faunas, as land barriers". He also reminds us that "such differences may also be due to the fact that we are not dealing with strictly contemporaneous faunas, but with faunas of varying ages within the same geological system."

After drawing our attention to these aspects of the problem which we have to bear in mind while dealing with palæogeographical studies, Dr. Sahni proceeds to deal with the subject proper of his address and gives an account of the land and water connections which existed between India and the adjacent countries at different periods between the Vindhyan and Devonian times, in the light of the most recent palæontological studies made in these different areas. Some of his main conclusions are (i) "a correlation between the Vindhyans and Cambrian strata seems unjustifiable though one may certainly concede that the physical conditions remained unchanged from the Vindhyan to Cambrian times." (ii) "The Lower Cambrian in Southern and Western Asia was dominantly a continental period. ..... The Middle Cambrian was a period of widespread marine transgression and the Middle Cambrian sea extended from north-west America to western Asia, as far perhaps as the Dead Sea." (iii) "The close of the Ordovician or early Silurian marks a period of profound marine transgression over India, Burma, Indo-China, Yunnan as well as central and southern China. Indeed this transgression which appears to have reached its zenith in Wenlock times, affected the European continent as well as north America; and one common Silurian ocean seems to have spread round the northern hemisphere." (iv) "The commencement of the Devonian witnesses one of the most interesting episodes in the geology of southern Asia, namely, the sudden influx of a fauna which bears no relation to the faunas of immediately surrounding regions, but is a prototype of the far Mediterranean Lower Devonian fauna. ..... The marine transgression which took place in Middle Devonian times has few parallels in the geology of Asia. This resulted not only in the intermingling of the Asiatic fauna of different regions, but also, as emphasised by Reed, in the breaking down of barriers of Asiatic and European life provinces which gave rise to similar faunas in widely separated regions."

L. R. R.

11

AGRICULTURE

President: Mr. K. Ramiah

PLANT BREEDING AND GENETICAL WORK IN INDIA

PLANT breeding has formed an important part of the work of agricultural departments in India from the very beginning. The improvement in the plant types aimed at has been in the direction of enhanced yield per acre, rather than in respect of quality, inasmuch as the money return to the grower depends under present conditions upon a bigger yield than on better quality, even though the need for improved quality in a crop like cotton, for instance, is very great. The lack of exact knowledge as to what constitutes quality, the difference between the consumer's estimates of quality and those based upon scientific standards of nutrition, and the fact that a superiority in quality is sometimes offset by a lower yield and a lesser money return have retarded progress in the direction of improvement in quality. The practical results of plant breeding work in the country are very striking although the work has been in progress for a period of hardly thirty years. Taking the four important crops, rice, wheat, sugarcane and cotton, the area under the improved strains evolved by the departments covered in 1937–38 5·2, 19·5, 74·3 and 22·2 per cent. respectively of the total area under these crops. Were it not that in India there are peculiar difficulties in carrying out and financing a large-scale distribution of the seeds of improved types, these varieties would have extended over a much larger area and the work of the plant breeder benefited more growers. The extent of increase in yield is never less than 10 per cent., but is generally a good deal more and even markedly so as in the case of sugarcane. A mere comparison of the average yields of crops in the published statistics for the whole of India, with similar figures of other countries, does not give a true picture of the results achieved by breeders. Compared with the total crop areas in a country as large as India with its wide climatic variations and other conditions, the areas under improved varieties are small, and the increased yields thereon are not only masked, but the potentialities of the variety are reduced materially by lack of adequate manuring, irrigation and the like. The cotton Co. 2 and certain rice strains in Madras have demonstrated possibilities under favourable conditions, and it may be claimed that both in respect of standards of work and of the results achieved plant breeding work in India is quite comparable with the work done in more advanced countries. In this connection attention is drawn to the admittedly unsatisfactory figures of the Indian crop statistics, and recent attempts to rectify matters are referred to.

In India as elsewhere plant improvement has been sought to be effected by the three familiar methods of introduction, selection and hybridisation. The first is very limited in scope, in

view of the variety of local conditions of environment which have already brought about the most suitable adaptations. In respect of selection among the self-fertilised crops, wheat, jowar, rice and other cereals, the aim has practically been an isolation of pure lines and subsequent testing to find out the best among them. The picking out of the primary selections in the mixture of types which is mostly the case has to be largely left to individual skill and the practised eye, and success depends on the large number of selections handled in the test. The practical difficulty of testing accurately, the very large number of types involved is now materially reduced by recent advances in statistical methods, notably, the incomplete randomised blocks method and modifications thereof; thanks also to the statistician, it is possible even to carry on simultaneously with the tests on the breeders' plots, tests in the cultivators' fields, and thereby to secure a speeding up of the process. Secondary or further selection after this stage, taking only the yield character, the scope for improvement is little, and in any case there are no records of systematic secondary selection in the cereals. Even in the case of cotton, as far as yield is concerned, secondary selection is of small importance, and the secondary selection, which nevertheless is generally practised, has been in respect of ginning percentage and length of fibre in which heterozygosity persists even after severel generations of selfing. Genetic variability, which is the starting point for selection, is often masked by the effect of environmental variation, but a method has been evolved to study them freed from such interaction. By this method improvement in cotton has been effected in Indore in characters for which the type was considered to have been fixed; it has furthermore been applied to the evolving of wilt resistant types, whereby from material showing 60 per cent. wilt mortality types showing less than 10 per cent. mortality have been selected. Even in cereals the method showed that, though there was no progressive improvement in yield by secondary selection, genetic variability could still be demonstrated, such as, the lodging of straw.

In regard to the third method of plant breeding, *viz.*, hybridisation, the production of genetic variation by crossing gained the scientific foundation necessitated by the rediscovery of Mendel's laws, which also gave rise to great hopes that many valuable attributes coming from different parents could be combined in a single new plant. These hopes have not been realised, if we take increased yield as a criterion of plant improvement. Greater success has, however, been attained in other directions like disease resistance; Prof. Biffen's, rust resistant wheats and Prof. Nilsson-Ehle's winter resistant wheats and barleys, in Europe and the wilt resistant *arhar* of Pusa, wilt resistant cotton of Bombay and the blast resistant rice of Madras are notable examples.

On the subject of mixture *versus* pure types the address is reminescent of the heated controversy on this subject of thirty years ago, and the views expressed are not only different from orthodox ideas, but have important bearing on the course of future practical work. Experimental evidence is brought forward to show that mixtures have given a higher yield than their components, and it is explained that the undoubted superiority of pure types over mixtures in the case of rice, cotton, jowar, etc., applies only within a limited range of conditions existing in the tracts where they were evolved, and that mixtures would prove more useful over a wider range of conditions. It is also stated that some crops like the Upland cotton of Central India do better in competition with others than when grown pure. The former suffers less from leaf roll and red leaf when grown in association than when grown pure. The resulting mixed cotton has also been found to possess a higher spinning value than the average of the two constituents, giving thus a higher money value to the mixed cotton. Notwithstanding well-established ideas to the contrary on this all-important matter these opinions of such a great authority merit serious consideration.

The address then traces the progress of genetical science through its several phases, the study of the chromosomes as the carriers of the hereditary units, the genes, research in cytology, attempts at wide interspecific crosses, the use of X-rays, colchicine and other agents for the alteration of chromosome numbers and the production of mutations quickly and more abundantly—all of which have helped to afford to the plant breeder greater control over his material, although as far as practical results are concerned much has not followed this progress in the new science. A notable exception, however, is provided by the work on maize in America. In India genetics comprised largely a study of the inheritance of simple characters which were all found to obey simple Mendelian ratios. Yield, ginning percentage, staple length and similar characters which, as the resultant of several single unit characters, are controlled by numerous genes have not received much attention on account of the great difficulties in following their complex inheritance. The actual contribution has been by way of selections, many of which however were found of limited adaptation necessitating the opening of breeding stations on an extended scale for evolving strains suited to different environmental conditions. In hybridisation a knowledge of the inheritance of the characters which are sought to be combined was lacking in India and advance was due to a hit or miss method and success was the result of accident. The estimation of genetical variance as an aid to selection is then illustrated by some recent work on certain cotton crosses by a highly complicate statistical technique. The extent to which heterosis can be profitably made use of in breeding is next discussed and *bajra* is suggested as a suitable crop for the utilisation of this method, which in the U.S.A. has produced the famous hybrid corn of that country. The question of correlations is then taken up, and the poor chances of combining characters where the correlation is physiological is stressed by the examples of failures of work in combining high yield with short duration in rice in Madras. There is a greater chance in respect of genetically

correlated characters though even here there are limits to such combination. The use of the 'discriminant function', by which the component factor which shows the least variation due to environment is determined and utilised, is referred to in the case of the components of the yield character in rice and cotton. Dealing with the subject of wide crosses, the advantage in respect of hardiness and resistance to diseases secured by crossing with wild types is pointed out, which has also been availed of an Indian work. Some outstanding work on wide crosses are already to India's credit, and the bamboo sugarcane cross and the sorghum sugarcane cross of Venkataraman, and crosses effected between Asiatic and American cottons are all referred to. It is, however, pointed out that there is a limit to the amount of combination of characters expected in wide crosses owing to the tendencies of certain parental species characters to stay together, these being borne but by the failure of certain rice crosses in Madras and the U.P. to come up to expectations.

The address next deals with the need for maintaining strains pure and combating the tendency to deteriorate, keeping up a nucleus in the breeding stations and again for the carrying out of basic research in genetics. Though a certain amount of such research has been in progress at various centres in India it is claimed that with greater co-ordination more valuable results can be expected, as has been achieved in the study of the chromosomes of maize in America. A plea is also put in for the formation of a Bureau of Plant Introduction for India on the American model and for the introduction of genetics as a subject of study in the Veterinary Colleges of India. The address concludes by emphasising the desirability of a change of outlook in the botanical teaching of our Universities, firstly by the introduction of genetical studies of agricultural crops in the syllabus and secondly by establishing greater contact between the Universities and the agricultural departments, such contact having already proved fruitful, as exemplified in the case of the work on the rusts of wheat and that on statistical methods applied to agriculture.

A. K. Y.

THE MAGNETIC ACTIVITY OF THE YEARS 1939 AND 1940

BY

M. R. RANGASWAMI

(Colaba Observatory, Bombay)

THE magnetic activity for the years 1939 and 1940 was larger than that for the year 1938, as seen from the magnetograms of the Alibag Magnetic Observatory. The method adopted by the Bombay Observatory for determining the magnetic characters of individual days is that recommended by the International Commission of Terr. Mag. and Atm. Elec.[1] The mode of classification of days into *quiet* and *disturbed* days has been described in an earlier note.[2]

During the year 1939 there were 95 quiet days, 229 days of slight disturbance, 32 of moderate disturbance and 9 of great disturbance. In 1940, there were 101 quiet days, 222 days of slight disturbance, 36 of moderate disturbance, 5 of great disturbance and 2 of very great disturbance. During 1939, according to both Bombay and International classifications, April was the most disturbed month and November the least disturbed one. For 1940 International Character figures are not available but according to Bombay classification only, April was the quietest month. March can be considered to be the most disturbed month although the monthly mean character for March was slightly lower than that for January. The mean monthly characters for the year 1939 according to Bombay and International[3] classifications based on data from 62 observatories are given in Table I.

TABLE I
(Magnetic Characters, 1939)

Month	Classifications	
	Bombay	International
January .	0·71	0·51
February .	0·89	0·86
March .	0·97	0·96
April .	1·03	1·01
May .	0·94	0·93
June .	0·83	0·78
July .	0·97	0·83
August .	0·77	0·66
September .	0·70	0·66
October .	0·97	0·87
November .	0·70	0·47
December .	0·77	0·63
Year .	0·854	0·763

[1] *Vide* their Circular letter of March 1924.

[2] *Current Science*, 1940, **9**, 90.

[3] Van Dijk, G., *Terr. Mag.*, 1940, **45**, 351.

The monthly mean characters for 1940 according to Bombay classifications only have been given in Table II.

TABLE II

(*Magnetic Characters*, 1940)

Month	Bombay Classification
January ..	1·06
February ..	0·72
March ..	1·03
April ..	0·70
May ..	0·77
June ..	0·77
July ..	0·71
August ..	0·87
September ..	0·77
October ..	0·74
November ..	1·03
December ..	0·90
Year ..	0·839

The Bombay Characters for the years 1939 and 1940 are nearly equal being 0·854 and 0·839 respectively. The number of days of different Characters in individual months during the years 1939 and 1940 have been given in Table III.

During the year 1939, there were 17 magnetic storms of moderate intensity and 7 of Great intensity. In 1940 there were in all 18 storms of which 14 were of moderate intensity and 3 of great intensity and 1 of very great intensity. The storm of very great intensity began at 13*h*. 50*m*. G.M.T. on Easter Sunday, March 24, 1940, and ended at about 18·5 hours the next day. This, the most violent storm recorded by the Bombay Observatory during the last 70 years, caused considerable havoc to telegraph, radio, telephonic and telephotographic communications. Besides, it caused disturbances to electric power systems. Similar disturbance had never been observed in the case of any severe magnetic storm in the past. During the intensest period of this storm the traces at some of the magnetic observatories of the world went off the photographic chart; this has resulted in a large number of these observatories equipping themselves with wide-range magnetographs. According to McNish, this storm probably stands pre-eminent in the annals of terrestrial magnetism.[4] For a detailed description of this storm as recorded by the instruments at the Alibag Magnetic Observatory, reference is invited to an earlier note[5] in this Journal.

Among the storms of Great intensity, the one of February 24, 1939 was associated with the display of Aurora Borealis in Great Britain. The times of commencement and cessation of the storms of Great and Very Great intensity together with the ranges of different elements during the storms are given in Table IV.

TABLE III

Year	Month	Bombay Classification		
		0	1	2
1939	January .	9	22	..
	February .	8	16	4
	March .	4	24	3
	April .	4	21	5
	May .	5	23	3
	June .	6	23	1
	July .	9	14	8
	August .	11	16	4
	September .	11	17	2
	October ..	8	16	7
	November .	10	19	1
	December .	10	18	3
	Total ..	95	229	41
1940	January ..	4	21	6
	February .	9	19	1
	March ..	9	12	10
	April .	13	13	4
	May ..	9	20	2
	June ..	9	19	2
	July ..	10	20	1
	August .	6	23	2
	September ..	9	19	2
	October ..	10	19	2
	November .	7	15	8
	December ..	6	22	3
	Total .	101	222	43

[4] McNish, *Terr. Mag.*, 1940, **45**, 360.

[5] *Current Science*, 1940. **9**, 167.

TABLE IV

Date	G. M. T. of Beginning		G. M. T. of End		Ranges D	Ranges H	Ranges Z	Intensity G = Great V. G. = Very Great
	H.	M.	D.	H.	/	r	r	
1939, Feb. 24	02	42	25	22	8·5	>335	37	G.
Apr. 17	01	57	18	00	8·2	345	83	G.
„ 24	17	37	25	23·5	8·0	370	43	G.
June 13	16	47	14	18·5	7·3	217	71	G.
Aug. 12	01	42	14	15	9·0	261	73	G.
„ 22	00	42	23	19·5	10·2	315	58	G.
Oct. 13	02	03	14	00	10·0	294	62	G.
1940, Mar. 24	13	50	25	18·5	17·1	>785	>100	V.G.
„ 29	16	02	31	02·5	7·9	266	74	G.
Mar. 31	09	42	Apr. 02	22·5	5·9	242	41	G.
June 25	02	54	26	07	13·9	340	96	G.

IDENTIFICATION OF COMMERCIAL TIMBERS

THERE are now more than 500 Indian timbers that are known to commerce. Of these only a few can be recognised by their look. Carpenters, timber contractors and others who handle timbers are often quite good at recognising them by their superficial colour and grain, but experience has shown that colour is a variable factor and that superficial grain depends considerably on the method of conversion. The most accurate way of identifying a timber is by its anatomical structure that can be seen in the cross-section. The colour of teak timber may vary, depending on the locality in which the tree grows and its superficial grain may be different in differently converted timbers, but its anatomical structure in the cross-section will seldom vary. This fact is well utilized by the Wood Anatomists or Wood Technologists, who make a thorough study of various timbers and collect data on their anatomy. Their method of study is often slow and laborious and the data collected by them may have to pass the critical eyes of the statistician and yet some practical results are achieved. Samples of timber are daily received by the Wood Technology Department of the Forest Research Institute from people who want to know whether they have obtained the correct timbers for certain specific uses. It is becoming more and more evident that a great number of people now realise that the use of a wrong timber often results in considerable financial loss. Help of this kind is being continuously given by the Wood Technology Section of the Forest Research Institute to the various Provincial Governments, the Railways, the Defence Department, the Supply Department, the Royal Air Force, the Civil Aviation, the Public Works and Industries Departments, and to Corporations, business concerns and private individuals. Every year some 400 to 2,000 samples of wood are received for examination and report.

K. AHMAD CHOWDHURY.
Forest Research Institute,
Dehra Dun.

CENTENARIES

Green, George (1793–1841)

GEORGE GREEN, a British mathematician, was born at Sneinton, near Nottingham, July 14, 1793. His father was a miller. He was an almost entirely self-taught mathematical genius. In fact his first and most influential paper, *viz.*, *An essay on the application of mathematical analysis to the theory of electricity and magnetism* was published in 1828 long before he entered college. He joined the University very late—in 1833—after having been in his father's business for some years. His advanced age and inability to submit to the course of systematic training needed for the highest places in the Tripos acted as a handicap and he came out only as the fourth wrangler. Here is a contemporary remark on this: "Green and Sylvester were the first men of the year (1837), but Green's want of familiarity with ordinary boys' mathematics prevented him from coming to the top in a time race. It was a surprise to every one to find Griffin and Brumell had beaten him." In 1839 Green was elected to a fellowship of his college, *viz.*, Gonville and Caius College.

Green published nine papers including the one already mentioned, which was the first. This first paper, which is the most outstanding contribution of this genius, was published by private subscription at Nottingham. Only 100 copies were printed and it escaped the notice even of the English mathematicians till 1850–54 when Lord Kelvin reprinted it in three instalments in volumes 39, 44 and 47 of *Crelle's journal*. It was this paper that first introduced the term "Potential Function". Green wrote "The function V representing the sum of all the electric particles in the system divided by their respective distances from p ... will recur very frequently in what follows; we have ventured to call it the potential function belonging to the system."

The function generally denoted by G and constructed so as to satisfy Green's problem was given the name "Green's function" by James Clark Maxwell in about 1873. G is the potential due to the induced distribution on the bounding surface.

A most illuminating evaluation of Green's contributions to hydrodynamics and optics was given by Stokes in his reports to the British Association in 1846 and 1862 respectively.

Green read his last paper on 20 May, 1839. This finished the record of one who "as a mathematician stood head and shoulders above all his companions in and outside the University".

Green died at his native place 31 March, 1841.

S. R. RANGANATHAN

University Library,
Madras.

SCIENCE NOTES & NEWS

An Improved Burette.—Mr. S. L. Phansalkar, Factory Manager, B.M.S.S., Ltd., Borgaon, writes: In volumetric analysis the accuracy of the results depends upon the knowledge of the exact amount of the liquid delivered from the burette. In ordinary practice the burettes that are used have graduations on them such that 1 c.c. is divided into 10 parts, the reading being taken correct to the first place of decimals, the second figure being a personal factor of the observer.

In the micro-burettes, where the cubic centimetre is divided into 20 parts with markings for each division, with enough space separating each of them, the reading could be taken correctly to the third place of decimals; but the diameter of the tube in the micro-burette is so small that the convenient size of the burette has a limited capacity, usually of only 5 or 10 c.c. A micro-burette of substantially greater capacity would be unwieldy to operate and inconvenient in size.

In the titrations or other volumetric measurements in practice, where large volumes of liquids are to be measured, a micro-burette if used necessitates the frequent refilling of the burette with consequent trouble or if an ordinary burette is used the accuracy of the measurement has got to be sacrificed.

The burette described here retains the large capacity of an ordinary burette while it gives the accuracy that could be obtained with a micro-burette.

The improved burette consists of two suitably graduated tubes, one of which is of substantially smaller diameter (micro-burette) than the other (ordinary burette) the tubes being provided with an outlet common to both and a stop-cock by means of which the liquid can be discharged from the tube of large diameter to the outlet or to the tube of small diameter or the liquid from the tube of small diameter independently discharged through the outlet as desired.

According to the particular burette here illustrated the standard 50 c.c. burette with divisions for 1/10 c.c. is provided with a micro-burette of 0·5 c.c. capacity with 20 divisions on it, fused on to it on the stop-cock, the 20th division on the micro-burette being a little lower than the 50 c.c. mark on the burette. The stop-cock has got a "Y" hole bored through it, which allows connexion to be made between the burette and the micro-burette or the burette and the delivery tube or the micro-burette and the delivery tube when suitably turned.

The burette is used in the following manner:

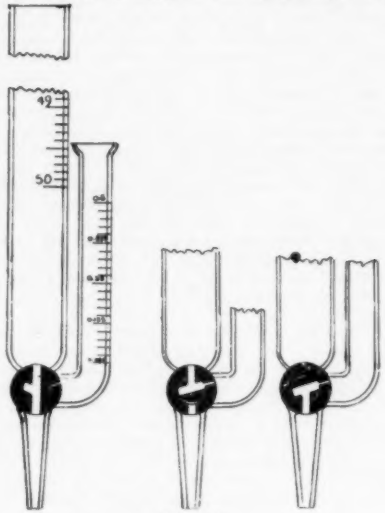

FIG. 1

After rinsing the burette and micro-burette with the liquid the burette is nearly filled to the zero mark, the air bubbles allowed time to escape, and then the stop-cock slowly turned so as to open the burette to the micro-burette and the liquid allowed to flow in the latter till it reaches the zero mark on it (micro-burette), when the stop-cock is closed and the level of the liquid in the burette adjusted to the zero mark.

The titration is carried out as usual, without disturbing the level of the liquid in the micro-burette. When the titration is complete and the level of the liquid in the burette coincides with the division mark on the burette exactly, there is no need to use the micro-burette as the reading obtained is itself quite accurate, but if it does not so coincide with any mark, then the stop-cock is slowly opened to make connexion between the burette and the micro-burette and the liquid is allowed to flow in the micro-burette until the level of the liquid in the main burette coincides exactly with a division mark on it, when the stop-cock is closed.

The readings on the burette and also that on the micro-burette are then taken. After the readings are taken the stop-cock is turned and the liquid in the micro-burette allowed to drain off until the level of the liquid in it once more coincides with the zero mark, when it is again ready for the next titration.

From the reading obtained on the burette the reading on the micro-burette is subtracted to give the exact amount of the liquid delivered from the burette.

As an example of the practical use of the burette let us assume that after the titration has been carried out the level of the liquid in the burette stood a little above the 8th mark above the 42 c.c. division—which means that a little more than 41 c.c. of the liquid has been delivered from the burette. The stop-cock is now properly turned and the liquid allowed to flow into the micro-burette until the level of the liquid in the burette falls down to the 41·5 mark, then the stop-cock is closed.

The level of the liquid in the micro-burette stands, say, half way between the 14th and the 15th marks and since the volume of the liquid in the micro-burette is equal to 0·025 c.c. per division is equal to $14{\cdot}5 \times 0{\cdot}025$ or at 0·362 c.c.

Then, the total volume of the liquid delivered from the burette is equal to

$$41{\cdot}5 - 0{\cdot}362 = 41{\cdot}138 \text{ c.c.}$$

An Abnormality in a Sathgudi Orange.—Mr. R. Ratnam, Lawley Road P.O., Coimbatore writes: In a consignment of *Sathgudi* or *Chinee* orange (*Citrus sinensis*, Osbeck: Tanaka[1]) (tight jacket type) received from Chittoor District of Madras Presidency, a case of a "fruit within a fruit" was noticed. The fruit was normal to all outward appearances but on peeling off the rind and opening out the carpels, a greenish yellow miniature fruit was found imbedded in the centre. The outer covering of the miniature fruit presented a glandular appearance just as the normal fruit of a ripe orange fruit. On opening it longitudinally, a central stalk with two cells was also seen.

Worsdell[2] has reported that this abnormality is found in the naval orange. He calls this phenomenon a case of "Positive Dedoublement" wherein a completely formed second small orange is developed inside the normal one. It does not, however, appear that this kind of abnormality has been reported previously in *Sathgudi* orange.

December 31, 1940.

Ultra-High Frequency Phenomena.—Studies in ultra-high frequency phenomena are gaining prominence in recent years as these frequencies provide the only channel through which successful high definition television is possible. The October 1940 issue of the *Proc. I. R. E.* contains two important papers on the subject. The first is by Waynick on the Propagation of Ultra-Short Radio waves of 41·5 and 45 mega cycles. The transmitter was located at Alexandra Palace television station in London and the signal strengths were recorded at the Cavendish Field laboratory situated at a distance of 71·3 km. which is 0·9 km. beyond the optical limit from a spherical earth. Further, the receiving antenna was well in the shadow of the Royston Hills. The output of the receiver was applied to the deflecting plates of a calibrated cathode ray oscilloscope whose deflection was linear with respect to the radio frequency voltage at the receiver input.

The fading which occurred over this transmission path could be broadly classified into two types (*a*) a fast low amplitude fading with a periodicity roughly of the order of half a minute and (*b*) a slow large amplitude fading

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1 Tanaka, T., *J. Ind. Bot. Soc.*, 1937, **16**, 227–40.

2 Worsdell, W. C., *The Principles of Plant Teratology*, Vol. II (The Ray Society, London), 1916.

of the order of 5 minutes or more. By observing the simultaneous fading on two receivers the spacing between which could be altered, the author concludes that the fading is probably due to a change in the direction and magnitude of ray curvature, fast fading resulting from small regions affecting the curvature. Good correlation between days of high signal strength and low tropopause temperature was obtained while meteorological conditions at ground level did not seem to affect the signal strength. At the frequencies employed and for the distances involved, no reflection from the ionosphere was possible—this was verified experimentally also—and hence it is concluded that fading is probably a refractive effect resulting from the density gradient of free air.

The second paper by Hamburger and Miller relates to the useful problem of the measurement of coil reactance in the 100 mc. region. A transmission line with the receiving end open was loosely coupled to a signal generator and adjusted to resonance by means of a sliding short circuit. The unknown reactance was then placed across the open end of the line and the short circuit moved a measured distance to restore resonance. The reactance could be calculated in terms of this distance and the constants of the transmission line. When the computed value of the apparent inductance (reactance/frequency) was compared with the experimental value of the same, the authors found that at about 100 mc., the experimental value of the apparent inductance was only 50 per cent. of the calculated value for a coil wound with thick copper wire while with thinner wire the experimental value was about 80 per cent. of the calculated value. The result is of special interest to those engaged in the design of chokes for ultra-high frequencies.

R. L. N.

Chemical Structures of Proteins.—The study of the breakdown products of proteins brought about by non-hydrolytic agents such as acetic anhydride has thrown fresh light on the structure of proteins. The results obtained since 1927, when the first paper on gelatin appeared, have been summarised by Prof. A. Fodor in a recent publication from the Hebrew University (*Scripta Academica Hierosolymitana*, Scientific Report No. 2, Jerusalem, 1939, pp. 84).

Proteins may be broken down by heating them to about 140° C. in non-aqueous solvents such as glycerine, β-naphthol, or acetic anhydride. The products resulting from this type of decomposition are designated *acropeptides*. They are split by proteinases only and not by peptidases. Gelatin, casein, edestin, egg albumin and the phospho-protein from yeast have been investigated in this way. Feigenbaum (*Enzymologia*, 1939, **6**, 122) studied the decomposition of fibrin by β-naphthol and isolated fractions of low molecular weight (700 to 900). Similarly, Kuk (*Enzymologia*, 1939, **6**, 194) has isolated from casein, products of low molecular weights representing nearly 2/3 of the original protein. The acropeptides from casein, gelatin and edestin were readily split by crude pancreas extracts and by purified proteinase preparations therefrom. These acropeptides were also attacked by pepsin but were unaffected by yeast polyptidases.

From these experiments, Fodor and his collaborators conclude that acropeptides are closed chain complexes consisting of four, or multiples of four, amino acids. These closed peptides are regarded as the fundamental building units of protein construction. As a result of the action of proteinases the closed peptide chains are opened out and only then peptidases exert their influence. As an answer to the objection that the acropeptides may be artefacts produced during the drastic treatment of the proteins, Fodor has pointed out that open chain polypeptides on similar treatment failed to form closed chain compounds. It must be stressed that the behaviour of the acropeptides towards enzymes is very suggestive.

P. R. V.

Infestation of Grain by Insects.—The recent report issued by the Department of Scientific and Industrial Research (1940, pp. 54, price 1*sh.* 3*d.*) gives the results of the survey carried on by J. W. Munro with the object of (1) investigating the occurrence of grain-feeding insects especially *Calandra granaria* and *Calandra oryzæ*, (2) ascertaining whether these weevils attacked home-grown grain in the field or in storage, (3) finding out the extent to which insects infesting grain are brought into the country on imported grain and feeding stuffs, and (4) investigating the channels by which the insects are distributed.

The survey shows that there is not only an endemic or "residential" population of grain insects persisting indoors, but a constant serious influx into the ports, with imported grain and feeding stuffs. The infestation of grain thus presents a dual problem of controlling the resident and the imported population of insects.

The grain insects can be classified under two heads, namely, primary and secondary. The primary pests are—the grain weevils, the flour beetles, "khapra" beetles, the flour or mill moth, the "cacao-moth", the spider beetles and the flour mites. The secondary pests are few and entirely dependent on the conditions created by their fore-runners.

The ports, forming the centres for distribution of grain and cereal products coming from overseas, are centres for the dissemination of insects. The transit sheds, General warehouses, Granaries, silos, mills and farms usually help in this spread of insects far into the country. The transport vehicles of various kinds are also carriers of insect population to different parts.

There is no single remedy and there will be no startling or easy remedies for the trouble and loss caused by insects. Several considerations restrict the use of insecticides. Dusts, sprays and fumigants are being investigated. It is very doubtful whether an insecticide suitable for general use to destroy grain and store insects will be available.

Jute Cultivation in Russia.—The *All-Union Institute of Plant Cultivation* has for the past 13 years been carrying on experiments in the cultivation of jute in the U.S.S.R. and has proved that the crop can be successfully grown in

the Soviet Union (Indian Central Jute Committee, *Bulletin* No. 11, February 1941). From among 150 varieties imported from India and various other tropical and sub-tropical countries and planted by the Institute in certain districts of Transcaucasia and Central Asia, the varieties *Corchorus capsularis* and *Corchorus olitorius* have been selected. These plants yield 13 to 25 per cent. of fibre, and produce a crop of seeds, which will make it possible to cultivate jute in the U.S.S.R. on an industrial scale. At present the Institute is trying to acclimatize varieties with a greater yield.

Tata Hall.—The Hall of the Bihar Commercial Museum, primarily designed to show the arts and crafts of peace, has been named "Tata Hall" in commemoration of the donation of Rs. 9,500 made by the Tata Iron and Steel Company to enable the Museum Committee to wipe off the last of its debts.

The naming ceremony of the Hall was performed by His Excellency Sir Thomas Alexander Stewart, K.C.S.I., K.C.I.E., I.C.S., Governor of Bihar, on the 19th February 1941.

Opening the Hall, His Excellency said, "The name which you have chosen is altogether appropriate; for not only does it commemorate the generosity of those who have contributed so handsomely towards the construction of this building but it is a name which stands for so much in the industrial development of Bihar. In declaring open this, 'Tata Hall', let me wish it continued success in the future".

Mr. J. J. Ghandy, General Manager of the Tata Iron and Steel Company, who was present on the occasion, said, "never in the past, was the need for commercial and industrial museums so great, as it is to-day, when a nation must industrialise or perish".

Mr. Ghandy outlined the war work of the Steel Company and concluded: "It may be said, and said with justification, that this war will be won or lost on the steel front. Permit me to assure you, that, in this grim hour of crisis, Tatas, the expanding arsenal of India, will not fail".

Apart from paintings showing the various sections of the Steel Plant at Jamshedpur, the Hall contains models of Blast Furnace, Bessemer Converters, Open Hearth, Tilting Furnace, Blooming Mill and the New Rail and Structural Mills, donated by the Tata Iron and Steel Company, and a few other exhibits.

Statistical Year-Book of the League of Nations, 1939–40.—Notwithstanding present events, the technical work of the League of Nations continues without interruption, says a recent Communique issued by the Information Section of the League of Nations. "Proof of this fact is furnished, *inter alia*, by the appearance of the *Statistical Year-Book of the League of Nations*, 1939–40. This new edition comes at an opportune moment when objective and comprehensive statistical information is more necessary than ever but—owing to the inaccessibility or absence of regular national publications—singularly difficult to come by. In spite of such difficulties the *Year-Book* is highly up to date. It contains figures covering the year 1939—in some cases also the first half of 1940—for a large number of subjects and for all countries of the world; the most recent territorial changes and the monetary measures introduced since the outbreak of hostilities are likewise reviewed in detail.

"Population problems are nowadays of considerable topical interest; population statistics accordingly occupy an increasingly prominent place in the *Year-Book*. These statistics deal not only with the present population position of the various countries, but also with their past and prospective future demographic evolution.

"The upward movement in industrial production, which began in many countries about the middle of 1938, continued up to the outbreak of hostilities and, in some cases, notably the United States and Canada, during the whole of the second half of 1939. However discordant the statistics relating to the U.S.S.R. may sometimes be, it is clear that a very striking increase in industrial production and in several branches of agricultural production has occurred in that country in recent years.

"The development of industrial technique, often encouraged by a policy of autarchy, has led to a growing use of substitutes. The German production of synthetic rubber in 1939 was estimated at 20,000 to 25,000 tons, world production of natural rubber amounting to 1,020,000 tons. Benzol, alcohol and synthetic motor spirit have in certain cases replaced petroleum spirit. In regard to textiles, the past ten years have witnessed a veritable revolution: while the world production of natural silk has tended to decline, the output of artificial silk (rayon) was in 1939 two and a half times greater than in 1930 and the output of staple fibres rose in the same period from 2,800 tons to 490,000 tons.

"A review of the monetary history of recent years brings out the spread and scope of the exchange control applied since the war in almost all countries of the world, the United States being a notable exception.

"In almost all countries note circulation has tended to rise; in some cases this tendency was accompanied by an increase in the reserves of central banks."

Indian Chemical Manufacturers' Association.—The second Annual Report of the Indian Chemical Manufacturers' Association, is, like the first, mainly a record of the Association's efforts to overcome the numerous difficulties against which the Chemical Industries in India have to contend. Almost all the important Indian firms manufacturing drugs and chemicals are now members of the Association and it is a matter for gratification that the Association has been able to secure recognition from the Government of India. Unfortunately, many of the grievances of the chemical manufacturers still remain unredressed, in spite of the strenuous fight which the Association is putting up, with the Provincial Governments, the Government of India, and the Railways. The correspondence between these bodies and the Association often shows the callousness and indifference with which even matters really

affecting the interests of the Chemical Industry are treated. Replies to letters addressed by the Association are often made months after they are received and frequently, the only action taken, appears to be to acknowledge the letter with thanks or a pious expression of regret that nothing can be done in the matter.

The first two annual meetings of the Association were held in Calcutta. Considering that the Association has now members from all parts of India, it will be very desirable to hold the next annual meeting at some other centre, say Bombay or Madras. This will help to maintain the all-India character of the Association.

Another suggestion, though on a comparatively minor point, may not be out of place. The authorities concerned would do well in future, to pay a little more attention to the language of the Report. It is to be regretted that there is hardly a page in the Report for 1939–40 which does not contain at least three or four glaring mistakes of grammar or idiom.

In other respects the Report is an excellent one and every chemical manufacturer would do well to read it. C. V.

Royal Asiatic Society of Bengal.—A special lecture was delivered at the Society's Rooms on Monday, the 10th March 1941, at 5-30 p.m. by Dr. F. Vreede, Hon. Director of the Netherlands Centre of Studies of the University of Paris, on "The Living Culture of Java and Bali". The lecturer pointed out that "the unity noticed between the Hindu Civilization of the Balinese, and the Islamic Civilization of the Javanese, which strikes even tourists in the daily life of these two highly artistic, religious and equally cultured peoples, is mainly due to a common ancestral, Indonesian tradition, greatly influenced however by ancient Hindu colonisation.

"This common background manifests itself to the present day in their shadowplay, theatrical dances and a vast ensemble of social habits and customs of a ritualistic, magic or animistic nature. The characteristic feature of both the Balinese and the Javanese Civilizations is nevertheless their spiritual and realistic view of life, which might prove one day a valuable contribution to a new world culture."

The Entomological Society of India.—The Third Annual General Meeting of the Entomological Society of India was held at Benares on the 3rd January 1941. The General Secretary's annual report showed that at the end of 1940 the Society's membership had reached a total of 114. Its income from members' subscriptions and other sources during 1940 was Rs. 2,333 and taking into account the previous balance to the credit of the Society and the expenses incurred during 1940, the Society had a net saving of over Rs. 2,000 at the end of the year. The main activity of the Society was the publication of the *Indian Journal of Entomology*. The Society's branches at Lyallpur, New Delhi, Pusa, Calcutta, Coimbatore and Karachi are maintained.

The following Office-bearers were elected:—
President: Dr. T. V. Ramakrishna Ayyar (Coimbatore). *Vice-Presidents*: Dr. N. C. Chatterjee (Dehra Dun), and Dr. Khan A. Rahman (Lyallpur). *General Secretary*: Dr. Taskhir Ahmad (New Delhi). *Joint Secretary and Treasurer*: Mr. H. L. Bhatia (New Delhi).

The Indian Society of Genetics and Plant Breeding was inaugurated at the recent meeting of the Indian Science Congress, Benares, 1941. The following Office-bearers were elected for the year 1941:—
President: Rao Bahadur T. S. Venkataraman. *Vice-Presidents*: Dr. W. Burns and Mr. K. Ramiah. *Secretary*: Dr. B. P. Pal. *Treasurer*: Dr. S. Ramanujam.

The Society will publish a journal in which papers on Genetics, Plant Breeding and Cytology will be published.

Indian Ecological Society.—This Society was inaugurated on 6th January 1941 at the time of the meeting of the Indian Science Congress Association held at Benares.

Its object is to cultivate and promote the study of plant and animal ecology by closer cooperation with Botanists, Zoologists, Geologists, Meteorologists, Agriculturists, Soil scientists, Chemists and Geographers.

The following were elected Office-bearers of the Society for 1941:—
President: Prof. S. P. Agharkar (Calcutta); *Vice-Presidents*: Dr. N. L. Bor (Dehra Dun), and Dr. S. L. Hora (Calcutta). *Secretary and Treasurer*: Dr. F. R. Bharucha (Bombay). *Members of the Executive Committee*: Mr. P. W. Davis (Ootacamund), Prof. P. W. Gideon (Dharwar), Dr. R. D. Misra (Bhagalpore), Dr. L. A. Ramdas (Poona), and Dr. T. S. Sabnis (Cawnpore).

All correspondence to be addressd to the Hon. Secretary, Royal Institute of Science, Bombay-I.

Indian Drugs for Export.—The following drugs are being produced in India in sufficient quantities for export, according to the Director-General, Indian Medical Service:

Alcohol, Alumen, Belladonna (*Atropa belladona*), Carbonei Dioxidum, Chirata, Digitalia (*Digitalis purposes*), Ferri Sulphas, Gum Indici, Hyoscyamus (*Hyoscyamus niger*), *Jalapa* (*Ipomœa Turpethum*), Kaolinum, Lobelia (*Lobelia Nicotianifolia*), Num Vomica B.P., Oil Vegetable hardened, Oleum Arachis, Oleum Eucalypti, Oleum Hydnocarpi, Oleum Mornhuee (substitute from shark liver oil), Oleum Ricini, Oleum Terebinthinæ, Opium and Crude Morphine Salts, Podophyli Resina (*Podophy Ilum emodi*), Rheum (*Rhubarb*) (*Rheum emodi*), Santoninum, Scilla (*Heginea Indica*), Sannæ Folium, B.P., Strychninea Hydrochloridum.

University of Mysore. *February* 1941:—

I. The Corner Stone of the new building for the Intermediate College at Shimoga was graciously laid by His Highness the Maharaja of Mysore, on the 12th February 1941.

II. A meeting of the Senate was held on the 27th February 1941. Among the propositions that were passed, mention may be made of the following: (1) The adoption of the Budget Estimates of the University for 1941–42.

(2) Detailed syllabus and revised scheme of examination in Geography for the Intermediate Examination in Arts and Science. (3) Revised detailed course of study in Psychology for the B.A. Honours Degree Examination. (4) Addition of Urdu in the list of subjects that may be offered for the Degree of Master of Arts. (5) Ordinance respecting the institution of the Master's Degree in Engineering. (6) Ordinances relating to the Institution of the Doctorate, *viz.*, D.LITT., D.Sc., D.E., and D.Sc. (Anatomy, Physiology). (7) Recommendation for the increase of the representatives of the Registered Graduates on the Senate to nine with a stipulation that at least three of them should be women. (8) Recommendation that the Senate be given the privilege of electing 5 of its members to the University Council, at least two of them being women. (9) Recommendation to the University Council for the allotment of a larger amount of scholarships to Depressed class students in the University. (10) Recommendation to the University Council to arrange for a course of lectures by specialists in Politics and Economics on pre-war and post-war economics and political problems, particularly with reference to Post-War International and National Reconstruction.

SEISMOLOGICAL NOTES

During the month of February 1941, 3 moderate and 6 slight earthquake shocks were recorded by the Colaba seismographs as against 1 moderate and 10 slight ones recorded during the same month in 1940. Details for February 1941 are given in the following table.

MAGNETIC NOTES

The month of February 1941 was on the whole more active than the preceding month. There were 5 *quiet* days, 22 days of *slight* disturbance and one of moderate disturbance as against 9 quiet days, 19 of slight disturbance and one of moderate disturbance during February of last year. The day of largest disturbance during February 1941 was the 13th and that of least disturbance the 27th. The characters for individual days are given in table below.

Quiet days	Disturbed days	
	Slight	Moderate
5, 16, 19, 20, 27.	1–4, 6–12, 14, 15, 17, 18, 21–26, 28.	13.

No magnetic storms occurred during the month of February this year as also last year. The mean character figure for the month of February 1941 is 0·86 as against 0·72 for February of last year.

M. R. RANGASWAMI.

Date	Intensity of the shock	Time of origin I. S. T.		Epicentral distance from Bombay	Co-ordinates of the epicentre (tentative)	Depth of Focus
		H.	M.	(Miles)		(Miles)
4	Moderate	19	33	3280	Near 15° N., and 123° E., about 150 miles to the east of Manila	200
7	Slight	20	43	5400		
9	Moderate	00	16	3410	Near 0° and 120° E , to the north of Celebes Island	
9	Slight	09	46	4270		
10	Slight	00	50	5430		
16	Moderate	22	9	1530		
23	Slight	9	56	1750		
25	Slight	11	8	4000	Near 11° S. and 124° E., in Timor Sea	
27	Slight	15	15	3580		

ASTRONOMICAL NOTES

Planets during April 1941.—Mercury continues to be a morning star and will be visible in the eastern sky for a short while before sunrise. Venus will be in superior conjunction with the Sun on April 19 and afterwards passes into the evening sky; the planet will be close to the Sun during the month and cannot be observed. Mars is in the Constellation Capricornus and rises about an hour after midnight. It is gradually getting nearer the earth and becoming brighter, its stellar magnitude at the end of the month being $+0{\cdot}6$.

Both Jupiter and Saturn are approaching the Sun and are not in a favourable position for observation. They can still be seen as fairly bright stars low down in the western sky soon after sunset. Uranus is in Taurus and continues its slow eastward march; it will be close to Jupiter at the end of the month. Neptune will be on the meridian at about 10 p.m. and moves in a retrograde direction very near the star β Virginis (magnitude 3·8).

Comet 1941 f Photograph taken on February 21, 1941 Exposure $1^h\ 20^m$.

Nizamiah Observatory, Hyderabad.

Comets.—The bright comet which appeared about the end of January 1941 has considerably faded and by the end of last month became too faint to be visible to the naked eye. With a binocular or a small telescope, the object continued to present an interesting appearance and the tail although shorter than before could be traced to about a degree or so in length. The magnitude at the beginning of this month was estimated to be about 7·0. The apparent motion has become much slower and for a few days more, the comet can be seen in the western sky a little away to the south-west of Jupiter and Saturn.

T. P. B.

ANNOUNCEMENTS

Sir Shanti Swarup Bhatnagar has been appointed Chairman of the Indian Lac Cess Committee, *vice* Mr. Gilmore resigned.

Sir M. Visvesvaraya has been re-elected President of the Court, Indian Institute of Science, Bangalore, for the year 1941–42.

Adams Prize: Subject for 1941-42.—The Adams Prize, which is open to the competition of all persons, including women, who have at any time been admitted to a degree in the University of Cambridge, is awarded for an essay, the subject proposed for the period 1941–42 being "The theory of the elementary physical particles and their interactions". The essay may contain a discussion of the properties of some or all of the elementary physical particles and of their associated fields; the theory of cosmic rays and the structure of nuclei come under the scope of the subject. The value of the Prize is about £288, but may be increased when it seems desirable to the adjudicators, on occasions when the prize is divided. Provision is also made for the award of extra Adams Prizes in suitable cases. The essays must be sent to the Registrar of the University on or before December 31, 1942. (*Nature*, 1940, 146, 650.)

Note entitled **"A Light Effect in Chlorine under Electrical Discharge"** (this Journal, 1940, 9, 535): Prof. S. S. Joshi, in a letter addressed to us points out that paragraph 3 of the above letter beginning with "The phenomenon called A for shortness' sake" ..... and ending with "The present note, therefore, avoids their premature and undue identification" does not occur in the MSS. which he sent to us for publication. The publication of this paragraph, which occurs in the letter which gave cover to Prof. Joshi's contribution, is much regretted and may be considered as withdrawn.

We acknowledge with thanks the receipt of the following:

"Journal of the Royal Society of Arts," Vol. 89, Nos. 4574–76.

"Journal of Agricultural Research," Vol. 61, No. 3.

"Agricultural Gazette of New South Wales," Vol. 52, Pt. 1.

"Biochemical Journal," Vol. 34, Nos. 10–11.

"Journal of the Indian Botanical Society," Vol. 20, Nos. 1–2.

"Journal of Chemical Physics," Vol. 9, No. 1.

"Experiment Station Record," Vol. 83, No. 6.

"Indian Forester," Vol. 67, No. 3.

"Transactions of the Faraday Society," Vol. 36, No. 236.

"Indian Farming," Vol. 2, No. 2.

"Genetics," Vol. 26, No. 1.

"Indian Central Jute Committee," Vol. 3, No. 11 (Bulletin).

"Journal of the Indian Institute of Science," Vol. 23A, Pts. 2–7 and Vol. 23C, Pt. 1.
"University of Illinois Bulletins," Vol. 38, Nos. 13, 14 and 19.
"Review of Applied Mycology," Vol. 19, Pt. 12.
"The Mathematics Student," Vol. 8, No. 3.
"Journal of the Indian Mathematical Society," Vol. 4, No. 4.
"Indian Medical Gazette," Vol. 76, No. 2.
"Journal of Nutrition," Vol. 21, No. 1.
"Journal of the American Museum of Natural History," Vol. 44, No. 5.
"Nature," Vol. 146, Nos. 3707–12.
"Sky," Vol. 5, No. 4.
"Science Forum," Vol. 5, No. 3.
"Science and Culture," Vol. 6, No. 9.
"The Indian Trade Journal," Vol. 140, Nos. 1808–11.
"The Grass-lands of the Argentine and Patagonia" (Bull. No. 30. Herbage Publication Series).

BOOKS

1. The Travancore Tribes and Castes, Vol. III. The Aborigines of Travancore. By L. A. Krishna Iyer (University of Travancore).
2. "Ramanujan," Twelve lectures on subjects suggested by his life and work. By G. H. Hardy. (Cambridge University Press).
3. "A Mathematician's Apology" by G. H. Hardy. (Cambridge University Press).
4. "Man on His Nature" by Sir Charles Sherrington. (Cambridge University Press).
5. "The Chemical Composition of Foods" by R. A. McCance and E. M. Widdowson. (H.M. Stationery Office, London).
6. "A Text-Book of Zoology," Vol. II, by Parker and Haswell. (Messrs. MacMillan & Co., London).
7. "Classical and Modern Physics," A Descriptive Introduction. By Harvey E. White. (Chapman & Hall, Ltd., London).

ACADEMIES AND SOCIETIES

Indian Academy of Sciences: (*Proceedings*)

February 1941. SECTION A.—S. PARAMASIVAN: *Investigations on ancient Indian metallurgy. I. A pre-historic bronze bowl. II. Ancient Indian bronze coins of the 2nd and 11th centuries A.D.* R. VAIDYANATHASWAMY: *The ideal-theory of the partially ordered set.* V. C. VORA, P. M. BARVE AND B. N. DESAI: *Importance of dialysis in the study of colloids. Part VII. Colloidal zinc ferrocyanide.* With the progress of dialysis the cataphoretic speed first increases and then decreases, while the stability and conductivity continuously decrease. K. NEELAKANTAM: *Determination of lead permanganometrically (Low's method).* Hydrochloric acid, of strength $< 0{\cdot}5$ N, can be used in order to dissolve lead oxalate precipitates for titrating the liberated oxalic acid with permanganate. G. V. L. N. MURTY: *Ferric chloride as a permanent standard in the colourimetric estimation of nitrate.* P. I. ITTYERAH AND K. C. PANDYA: *Condensation of malonanilic acid with aldehydes. Part II. With* o-, m- *and* p-*hydroxybenzaldehydes. Part III. With* o-, m- *and* p-*nitrobenzaldehydes.* R. D. DESAI AND ABDUL HAMID: *Studies in naphthalene series. Part VIII. The preparation and properties of* 2:4-*dipropionyl*-1-*naphthol and* 4-*acetyl*-2-*propionyl*-1-*naphthol. Part IX. Properties of* 4-*propionyl*-1-*naphthol and the preparation of* 4-*propyl*-1-*naphthol.* D. A. A. S. NARAYANA RAO: *Raman Effect in gypsum.* Six frequencies due to SO_4 ion and two bands due to water of crystallization recorded and studied by means of the effects of orientation of the crystal on the Raman Spectra.

February 1941. SECTION B.—T. S. RAGHAVAN AND K. R. VENKATASUBBAN: *Contribution to the Cytology of* Tridax procumbens *Linn.*—The diploid and haploid chromosome numbers of *Tridax procumbens* Linn., have been reported for the first time to be 36 and 18 respectively. T. S. RAGHAVAN AND K. R. VENKATASUBBAN: *Studies in the Capparidaceæ—VI. Floral structure in* Cratæva religiosa *Forst., with special reference to the Morphology of the Carpel.*—Floral ontogeny and anatomy in *Cratæva religiosa* Forst., have been investigated in some detail. C. P. ANANTAKRISHNAN AND P. R. VENKATARAMAN: *The Chemistry of Garlic* (Allium sativum *L.*)—*Part III. The Reserve Polysaccharides.*—In addition to starch, the reserve polysaccharide is made up of mannose, fructose and a non-reducing acid.

Erratum

With reference to figures illustrating Professor B. Sahni's article on "Yaudheya Coin Moulds from Sunet, near Ludhiana in the Sutlej Valley" (Vol. 10, No. 2, February 1941, pages 65-67), the correct numbering is as follows:—

		1	2		
3	4			7	8
5	6			9	10
10*a*	11			11*a*	12

SUPPLEMENT TO CURRENT SCIENCE

Vol. X] MARCH 1941 [No. 3

LETTERS TO THE EDITOR

THE CONSISTENCY OF EINSTEIN'S NEW RELATIVITY WITH THE GEODESIC POSTULATE

EINSTEIN, INFELD and HOFFMANN[1] have recently obtained a solution of the problem of n bodies from the field equations

$$G_{\mu\nu} = 0, \qquad \ldots \qquad \ldots \quad (1)$$

no use being made either of the geodesic postulate or of the energy-momentum tensor. It is well-known that (1) stands for only six independent equations. Four conditions can therefore be chosen so that the co-ordinate system is fixed and all the ten components of the metric tensor, $g_{\mu\nu}$, are known. The procedure of these authors is to build up $g_{\mu\nu}$ to higher degrees of approximation in stages contravening the four co-ordinate conditions by introducing 4 n functions. When these functions are put equal to zero the equations (1) are satisfied and the 4 n equations so obtained reduce substantially to the required 3 n equations of motion. A full exposition of this method has been given elsewhere.[2] For two particles of masses m_1 and m_2, separated by a distance r, at η^m, ξ^m at time t the equations are of the type

$$\ddot{\eta}^m - m_2 \frac{\partial(1/r)}{\partial \eta^m} = m_2 \left\{ \left[\dot{\eta}^s \dot{\eta}^s + \frac{3}{2} \dot{\xi}^s \dot{\xi}^s - 4 \dot{\eta}^s \dot{\xi}^s - \frac{4m_2}{r} - \frac{5m_1}{r} \right] \frac{\partial}{\partial \eta^m} \left(\frac{1}{r} \right) + \left[4 \dot{\eta}^s \left(\dot{\xi}^m - \dot{\eta}^m \right) + 3 \dot{\eta}^m \dot{\xi}^s - 4 \dot{\xi}^s \dot{\xi}^m \right] \frac{\partial}{\partial \eta^s} \left(\frac{1}{r} \right) + \frac{1}{2} \frac{\partial^3 r}{\partial \eta^m \partial \eta^s \partial \eta^t} \dot{\xi}^s \dot{\xi}^t \right\} \qquad \ldots \qquad \ldots \quad (2)$$

Here m, s, t are suffixes running over the values 1, 2, 3, and the dummy-suffix convention is valid for them. A dot denotes as usual a differentiation with regard to t. The last equation gives the motion of m_1. In it m_1 appears only in one term on the right-hand side. If we put $m_1 = 0$ in (2) we get one term less and the equations of motion of a body of negligible mass are obtained.

The motion of a body of negligible mass is derived here without the use of the geodesic

postulate; the geodesics of the field of m_1 and m_2 can also be obtained in the limiting case $m_1 = 0$. The question in which one is interested is this. Will the equations of motion for the case $m_1 = 0$ as derived from (2) be identical with the corresponding equations derived from the geodesic postulate applied to the field satisfying (1)? If one studies the procedure of Einstein and his collaborators there is nothing to indicate that the two should be identical: and in fact their work is guided by the supposition that the two results need not be identical. On carrying out the necessary calculations we obtain the surprising result that the equations of motion of Einstein's new relativity such as (2) are fully in accord with the geodesic postulate at least up to the second order of the masses. The calculations in question are lengthy and they will be published elsewhere. It looks as if the result is not accidental for the number of terms involved in the equations is large. The two methods of deriving the equations, although so different apparently, might be logically interconnected.[3]

V. V. NARLIKAR.

Department of Mathematics,
Benares Hindu University,
February 24, 1941.

[1] Einstein, Infeld and Hoffmann, *Ann. Math.*, 1938, **65**, 5, 39.
[2] Narlikar, V. V., *J. Bombay Univ.*, 1939, **51**, 8.
[3] Narlikar, V. V., and Singh, J., *Phil. Mag.*, 1937, **628**, 23.

STANDARD ERROR OF THE DIFFERENCE BETWEEN TWO ESTIMATES FOR INCOMPLETE BLOCK EXPERIMENTS

THE calculation of the standard error for comparing two treatment estimates in the case of simple experiments, like randomized blocks or Latin squares, is easy and is equal to $\sqrt{2s^2/n}$, where s^2 and n are the residual variance and the number of times each treatment is repeated in the experiment. But in designs involving incomplete blocks, the algebraic expression giving the treatment differences will have to be written down for calculating their standard error. This is a very laborious and cumbersome procedure. A simple method for calculating the standard error of the difference between two treatment estimates for any experiment is given below:

First we determine the residual error of the whole experiment by subtracting the reduction in the sum of squares for blocks and treatments from the total sum of squares. To obtain now the standard error for the difference between any two treatments, calculate the sum of squares for the difference between the two treatments, as explained in a previous paper,[1] by subtracting the reduction in the sum of squares for blocks and treatments, assuming that there is no difference between the two treatments in question, from the sum of squares for blocks and treatments which has been determined before. Let this difference be A and the residual variance be s^2. It can be now shown that the standard error for the difference between the two treatments is equal to

$$\frac{s(t_1 - t_2)}{\sqrt{A}},$$

where t_1 and t_2 are the least square estimates of the treatments.

In the case of balanced incomplete blocks experiments, it is easy to see that the standard error for the difference between any two treatments is the same. But for asymmetrical experiments, this will be different for different differences.

P. V. KRISHNA IYER.

Imperial Agricultural Research Institute,
New Delhi,
January 14, 1941.

[1] *Proc., Ind. Acad. Sci.*, **11**, 369.

"EXPECTATION" OF GROWTH OF POPULATION

IN the *Indian Journal of Economics* of June 1940, Mr. D. Sen Gupta obtains the formula

$$y - d = \frac{k}{1 + ce^{rt}} \quad .. \quad .. \quad (A)$$

where y is the population, t is the time measured from a base year and c, d, k and r are

constants for extrapolating for population figures where birth, death and migration statistics are not sufficiently reliable.

2. It will simplify the notation if instead of t we write $10t$ as the time measured in years from the last census, and the figures for the decennial censuses in reverse order as a_0, a_1, a_2, ... etc., but the extrapolation formula is only required for intercensal use and we may, therefore, suppose $0 < t < 1$.

It is easy to see that a differential equation

$$\frac{1}{y}\frac{dy}{dt} = k(A - y) \quad .. \quad .. \quad (1)$$

where k and A are constants, connecting the proportional rate of growth of population with the amount by which the population at the time falls short of a constant number leads to the solution

$$y = \frac{A}{1 + e^{-Akt-c}} \quad .. \quad .. \quad (2)$$

where c is a fresh constant, which differs from (A) only in that it involves three and not four constants. It is easy to see that if the formula (1) holds the population is always above or always below A.

The constants involved can be evaluated in terms of a_0, a_1 and a_2 and we obtain a formula very similar to that of Mr. Griffiths referred to in the same paper.

3. To obtain an estimate of the effects of faulty computations of the constants A and k we differentiate logarithmically the formula

$$\log\left(\frac{A - y}{A - a_0} \cdot \frac{a_0}{y}\right) = -Akt \quad .. \quad (3)$$

obtained by using the fact that when $t = 0$ $y = a_0$.

4. Even if the A and k of the equation (1) change with time, but their changes in a period of thirty years are comparatively small, the population obtained from (3) would be fairly reliable. A and k will be characteristic of the population studied and if the formula is found to hold, the slow secular changes in these quantities should be of great interest.

5. A formula of this nature assumed to hold for comparatively short periods avoids the recent criticism of such sociological laws as Pareto's of claiming an improbable degree of universality. In passing, we observe that Pareto's Law is given an appearance of greater plausibility if we consider it as giving the "expectation" of receiving an income large in comparison with the average income of the group.

H. E. Peries.

The Chief Secretary's Office,
Colombo, Ceylon,
February 6, 1940.

ARC DISCHARGE IN MERCURY

The difference of potential across the electrodes of a mercury arc lamp in vacuum varies almost linearly with current, showing that here Ohm's Law holds good. It has been shown by Henri[1] that the voltage-current characteristic curve, however, showed a slight concavity towards the current axis for large values of current, when the arc was cooled by immersing the arc lamp under water.

We have been able to get a large number of characteristics for a sealed arc, at a pressure of about 0·5 mm., some of which are reproduced below (Fig. 1). The arc is cooled by blowing a current of air with an electric fan. By varying the distance of the fan, the lamp can be cooled to different degrees.

Curve I is a straight line characteristic. Curve II shows a negative or falling part in the characteristic as obtained when the lamp is cooled with the fan running at a distance of 4 metres. The succeeding curves show the falling parts more and more prominently as the cooling is increased. The falling part of the characteristic does not seem to have been observed by previous workers for mercury arcs.

The above curves show a minima of about 23·5 volts which appears to be almost independent of the degree of cooling. For this voltage the arc fills the whole of the cathode surface, while for voltages on the falling part of the characteristic the surface is only partially filled.

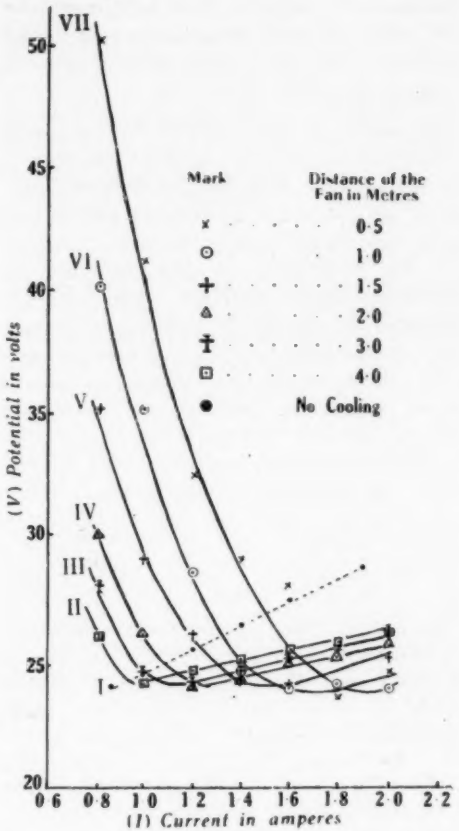

FIG. 1

Characteristic curves of a closed arc lamp at different coolings

Fig. 2 shows the characteristics as obtained with a mercury arc lamp at different pressures, the pressure being maintained constant by admitting different amounts of air into the lamp. The lamp was not cooled. It is seen that the minimum voltage point shifts to higher values of voltage as well as current, when the pressure is increased. The falling part of the characteristic comes out prominently at higher pressures, while at pressures below roughly about 0·2 mm. the negative part has been found to be entirely absent and no amount of cooling would bring it out. This would be sufficient to explain why the mercury arc characteristic was believed to exhibit only the rising characteristic. At extremely high vacuum, even the minimum voltage point as well as a part of the rising characteristic disappear. A detailed account of this and related observations will shortly appear in *Phil. Mag.*

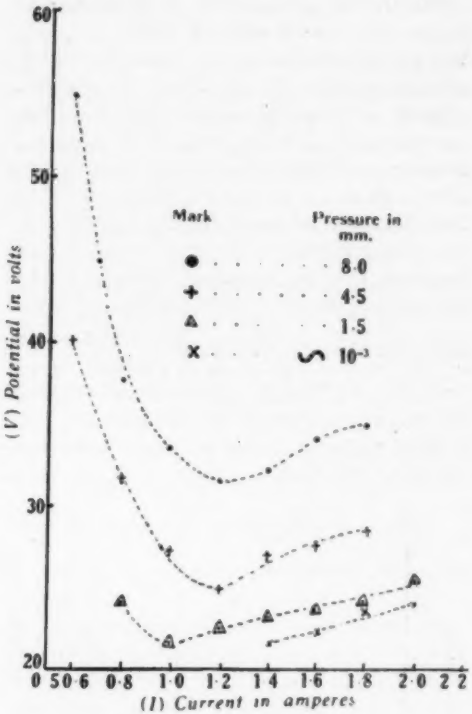

FIG. 2

Characteristic curves of an uncooled mercury arc lamp at different pressures

B. DASANNACHARYA.
C. DAKSHINAMURTI.

Department of Physics,
Benares Hindu University,
February 7, 1941.

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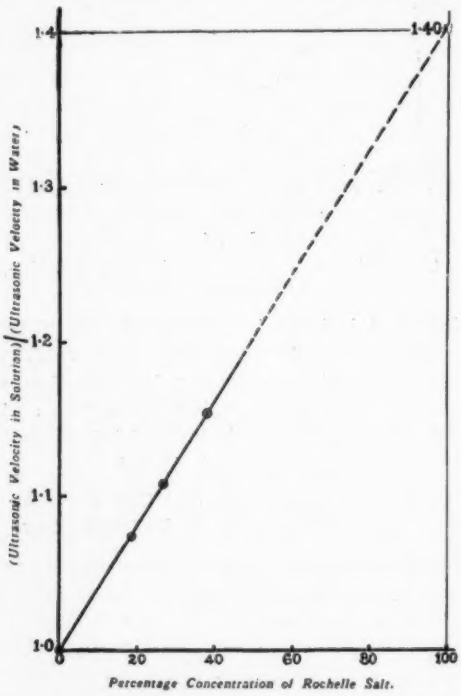
[1] Henri, *Comptes Rendus*, 1911, **153**, 426.

See also F. J. Teago and J. F. Gill, *Methuen Monographs*, page 5, 1936; and Fleming, *Mercury Arc and Rectifiers*, and Mercury vapour lamps (1925).

ACOUSTIC VELOCITY IN ROCHELLE SALT SOLUTIONS

THE physical and chemical properties of Rochelle salt [$KNaC_4H_4O_6$ $4H_2O$], which has numerous scientific and industrial applications, have been the subject of detailed study by a number of investigators. Assuming the values of the elastic constants in various directions of the Rochelle salt crystal as determined by Mandell,[1] the acoustic velocity in the crystal in any direction can be computed. For a random aggregate of minute crystals, the velocity can be estimated from the formula $V = \sqrt{\frac{K + \frac{4}{3}n}{\rho}}$ assuming for K and n the average values of the bulk and rigidity moduli and for ρ the density of the salt. The acoustic velocity computed on this basis comes out as 4,484 metres per second. From a study of the Doppler-Brillouin components in the light scattered by a single crystal of Rochelle salt one of us[2] has deduced a value of about 3,530 m./sec. for the velocity of compressional waves in the XZ plane in a direction equally inclined to those axes.



Schaaffs[3] has claimed that the ultrasonic velocity in a solid solute could be estimated by an extrapolation from the values of the velocities determined for solutions of various concentrations in any solvent. Some doubt regarding the justification for this procedure has previously been expressed. The ultrasonic velocities in solutions of naphthalene in various solvents give undoubtedly a mean value of 1554 ± 16 m./sec. for the extrapolated value of sound velocity in naphthalene.[4] It has been argued that this velocity is not characteristic of solid naphthalene and tentatively a hypothesis has been put forward that the velocity refers to a non-rigid solid state of naphthalene or to a condensed gas state. As the velocity in solid naphthalene is not known, some doubt may still linger as to the need for this hypothesis. But in the present investigation, the extrapolated value from aqueous solutions of Rochelle salt is shown to be too small compared with the velocity computed either from elastic constants or from light scattering data.

Employing the experimental procedure previously developed,[5] the ultrasonic velocities in aqueous solutions of Rochelle salt at different concentrations have been determined. Fig. 1 shows that the extrapolated value of the acoustic velocity in Rochelle salt is 1·40 times the velocity of sound in water and comes out therefore as 2092 m./sec. at 24° C. This velocity is considerably at variance with values computed from other data for a random aggregate of minute Rochelle salt crystals. Hence the view put forward by Schaaffs that the extrapolated value gives the velocity of sound in the solute is definitely shown to be incorrect. But it is undeniably a fact that this value is characteristic of the solute and can be safely used to compute beforehand the ultrasonic velocity in its solutions with any solvent, in which the sound velocity is known.

Further work is in progress and a detailed paper will appear elsewhere.

L. SIBAIYA.
R. L. NARASIMHAIYA.

Department of Physics,
Central College,
Bangalore,
February 12, 1941.

[1] Mandell, *Proc. Roy. Soc*, 1927, **116**, 623.
[2] Sibaiya, *Proc. Ind. Acad. Sci.* (A), 1938, **8**, 393.
[3] Schaaffs, *Zeits. f Physik.*, 1937, **105**, 658.
[4] Sibaiya and Narasimhaiya, *Ind. Sci. Cong.*, 1941, and *Mys. Univ. Jour.* (under publication).
[5] Narasimhaiya and Doraiswami, *Ind. Jour. Phys.*, 1940, **14**, 187.

VISIBLE ABSORPTION BANDS OF MERCURIC CHLORIDE

WHILE investigating the absorption spectra of the halides of various elements, a characteristic band system has been observed in the visible region with mercuric chloride, which has not been previously recorded. The substance is heated in a steel tube, open at both ends, in a coke furnace to a temperature of about 1000° C. The bands extend approximately between λ 4900 to λ 4200 and consist of sequences of distinct doublet bands. Three of the sequences are well developed. They are ascribed to the diatomic molecule HgCl and are considered to form part of the class III system of bands which are reported to be poorly developed in emission by Wieland.[1] A full account of the results will be published shortly.

A. L. SUNDARA RAO.

Andhra University,
Waltair,
February 9, 1941.

[1] Wieland, *Helv. Phy. Acta.*, 1929, **2**, 46.

ULTRA-VIOLET EMISSION BANDS OF MERCURIC CHLORIDE

THE ultra-violet band spectrum of mercuric chloride as excited in a discharge tube has been photographed with a Hilger Quartz-Littrow spectrograph. The band system between λ 2900–λ 2700 reported first by Wieland[1] as due to the triatomic molecule $HgCl_2$ has been studied in detail. The assignment of this system by Cornell[2] to the diatomic molecule HgCl, and the vibrational analysis suggested by him have been confirmed. Additional groups of bands lying towards the short wavelength of each of the Q_1 sequences, have been newly classified as forming the Q_2 sequences of the same system giving an electronic doublet separation of about 90 cm.$^{-1}$ The entire system is ascribed to the transition $^2\Pi - ^2\Sigma$. The lower state, $^2\Sigma$, is probably the same as the lower level of Wieland's class I system between λ 2650 – λ 2400. The vibrational constants, as derived from the Q_2 heads, are,

$$\omega_e' = 287{\cdot}8 \qquad x_e'\omega_e' = {\cdot}5$$
$$\omega_e'' = 281{\cdot}0 \qquad x_e''\omega_e'' = {\cdot}5$$
$$\nu_e = 36564{\cdot}2.$$

Details of the analysis will be published elsewhere.

M. G. SASTRY.

Andhra University,
Waltair,
February 9, 1941.

[1] Wieland, *Helv. Acta. Phys.*, 1929, **2**, 46, 77.
[2] Cornell, *Phy. Rev.*, 1938 **54**, 341.

INFANTILE MORTALITY AND BERIBERI

IN India beriberi as a serious public health problem is confined to the Northern Circars districts of the Madras Presidency. The disease is due to vitamin B_1 deficiency and is usually associated with the consumption of a diet consisting mainly of raw rice from which the outer layers, which contain most of the vitamin present in the grain, have been removed by machine-milling. About 70 per cent. of the rice-eating population of the Madras Presidency consumes machine-milled rice. The important difference between the dietary habits of the Northern Circars and those of the rest of the province is that in the former area raw rice is preferred to parboiled rice by the mass

of the population. Parboiled rice, in contradistinction to raw, remains rich in vitamin B_1 when highly milled, because the vitamin diffuses through the endosperm in the steaming process, and those who consume parboiled milled rice rarely suffer from beriberi. These questions are fully considered in "The Rice Problem in India"[1] in which the relation between the consumption of raw milled rice and beriberi in India was demonstrated.

In all Eastern countries apart from India in which beriberi is prevalent, the disease is known to be common among infants. It usually attacks breast-fed infants at about the third month of life, and is often fatal. Infantile beriberi has not, however, been reported in India. During visits to the Northern Circars we had the opportunity of observing clinically infantile cases which were unquestionably of this nature and this led us to suspect that infantile beriberi, though generally unrecognised, may be a serious problem in this area. Epidemiological investigations in hospitals and out-patient departments present considerable difficulties and we approached the problem by a study of the existing vital statistics relating to infantile mortality in a number of towns in the beriberi area and in other parts of the country.

The Annual Reports of the Director of Public Health, Madras, provide data about infantile mortality in municipalities in the Madras Presidency. Infantile deaths are grouped under the periods 0–1 month, 1–6 months, and 6 months to 1 year. A comparison was drawn between the proportionate mortality in these periods in 17 towns in the Northern Circars and 17 towns in the province south of Madras City in 1938, the total population concerned being approximately the same in each case. Only the records of municipalities employing health officers were investigated, because in such towns registration of births and deaths is likely to be fairly accurate. The results were as follows (Table I).

In the beriberi area infant mortality reaches its highest peak during the period 1–6 months. In the other towns and in British India generally,

TABLE I

Percentage of Total Infantile Mortality

Period	0–1 month	1–6 months	6–12 months
Towns in beriberi area (raw milled rice)	35·0	41·3	23·7
Towns outside beriberi area (parboiled milled rice)	53·0	26·6	20·4
British India (Report of the Public Health Commissioner with the Govt. of India, 1938)	46·8	30·6	22·6

the greatest proportionate mortality occurs during the first month. Further analysis showed that the reported infantile mortality in towns in the beriberi area is considerably higher than in towns outside the area, and that the excess mortality in the former is due to the larger number of deaths occurring in the group 1–6 months.

Municipal records were scrutinised to elicit the proportion of deaths at *each* month of infancy in three of the largest towns in each group, over a period of 10 years. In the towns in the beriberi area there was a striking peak in mortality at the third month, which was constantly present in all years and throughout the records of the 3 municipalities in question. It is highly probable that this peak, which was entirely absent in the records of the municipalities outside the beriberi area, is due to deaths from infantile beriberi.

The inaccuracy of vital statistics in India is well known. It may, however, be pointed out that registration of births and deaths in the Madras Presidency is more complete than anywhere else in India and that we were concerned with urban areas in which whole-time health officials were employed. Further, it is difficult to imagine how a sharp and constant peak in mortality at the age of 3 months, which revealed itself only on detailed study of the records, could be produced by errors and omissions in registration.

It is, in our opinion, very probable that a similar trend in infant mortality exists in all Eastern countries in which raw milled rice is the staple food—*i.e.*, that infantile beriberi has a specific effect on the proportionate mortality at different stages of infancy. Further investigations on this question, which is of great public health importance, are in progress.

W. R. AYKROYD.

B. G. KRISHNAN.

Nutrition Research Laboratories,
Indian Research Fund Association,
Coonoor,
March 5, 1941.

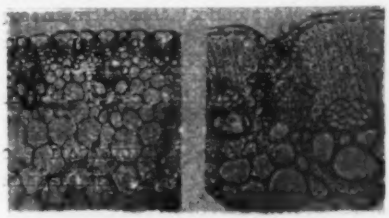
[1] Aykroyd, Krishnan, Passmore and Sundararajan, (1940), *Indian Medical Research Memoir*, No. 32.

HARD LEAF MID-RIB IN SUGARCANES AND RESISTANCE TO TOP-BORER (*SCIRPOPHAGA NIVELLA* F.)

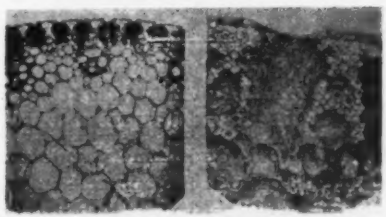
MR. P. V. ISAAC, Sugarcane Entomologist (Dipterist) at the Imperial Agricultural Research Institute, New Delhi, suggested in *Current Science* (May 1939, p. 211) hardness of leaf mid-rib in sugarcane varieties as a possible factor conducive to resistance to sugarcane top-borer (*Scirpophaga nivella* F.). This suggestion was made after an extensive examination of a number of cane varieties and seedlings in the field coupled with a study of the habits of the pest including the manner in which the larvæ enter the shoot.

Anatomical studies of various parts of the sugarcane plant—including those of various species of *Saccharum* (both wild and cultivated) and interspecific and intergeneric hybrids with *Saccharum*—have been in progress at Coimbatore, with the object of working out the inheritance of anatomical characters. The above suggestion of Mr. P. V. Isaac naturally attracted attention and structure of the leaf mid-rib was included in the studies.

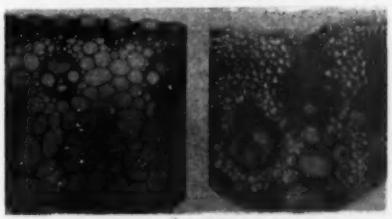
Leaf mid-rib specimens of resistant and susceptible varieties were obtained both from Coimbatore and from its substation at Karnal and sections taken at or near the hole made by the larvæ of the top-borer. The collection of the mid-rib specimens did not present any



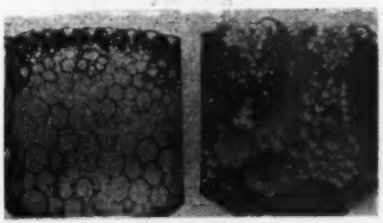
Co. 421



Co. 312



Co. 331



Co. 213

Cross-sections of leaf midrib
low power × 200 and high power × 500

difficulties. The studies have shown fair correlation between the thickening of the various mid-rib tissues and resistance of the variety to top-borer attack. The photo plate (Fig. 1) gives the mid-rib cross-sections of four canes, two of which, *viz.*, Co.'s 421 and 331 have

recorded markedly greater resistance than the other two, *viz.*, Co.'s 213 and 312.

The studies in progress have shown a definite inheritance of anatomical characters in sugarcane hybrids, and it would appear possible by a suitable choice of parents to introduce into new canes certain of the desired anatomical characters.

J. THULJARAM RAO.
T. S. VENKATRAMAN.

Imperial Sugarcane Station,
Coimbatore,
February 22, 1941.

THE CARDAMOM WEEVIL, *PRODIOCTES HAEMATICUS* CHEV. VAR IN SOUTH INDIA

IN some of the cardamom plantations in Travancore a new pest has appeared in *Prodioctes hæmaticus* Chev. var., which has been recently reported from Ceylon (Hutson, 1939) as a fairly serious pest in certain areas. The incidence of this pest in South India may have been very low till now and this may account for the absence of any record of this insect as a pest of cardamoms here.

The damage caused is during the grub stage when it tunnels into the rhizome and the basal portion of the pseudostem killing the attacked plant and gradually the associated ones also in the clump probably due to some pathogenic fungus either carried by the grub or getting access through the injured portion. The common shoot borer, *Dichocrocis punctiferalis*, is not responsible for the clump rot as only the attacked shoot is destroyed. A root boring caterpillar, (*Hilarographa* ?) is often met with but it does not bore into the rhizomes and its responsibility for the causation of the clump rot yet remains to be determined.

An account of the weevil pest in greater detail is being published elsewhere.

S. JONES.

Pampadampara Cardamom
Research Station, Trivandrum,
February 10, 1941.

[1] Hutson, J. C., *The Tropical Agriculturist*, 1939, **93**, 281.

A NOTE ON THE MINERAL WATER FROM SURANGUDI

SURANGUDI, a small village in Kulathur Zamindari in Tinnevelly District, is reputed to possess a well whose water is valued for its therapeutic qualities. At the instance of Sir P. S. Sivaswamy Iyer, K.C.S.I., who was interested in this mineral water, the geology of the area was studied. A chemical and a spectroscopic analysis of the water was also carried out.

The Zamindari lies within the coastal plain and is relatively featureless. This tract is gradually being elevated with respect to the sea, as evidenced by a shell bed 2 feet thick with recent species of *Arca* and *Cardita*, above the ground level at Surangudi. This rise must have taken place within historical times, as ancient edifices close to the coast are seen buried in sand dunes. Paving slabs of about a foot square, old pottery and coins of Raja Raja (985 A.D. to 1014 A.D.) are occasionally met with in fields.

The village stands on a hard massive dark-brown ferruginous lateritised gneiss. The rock is medium granular and shows patches of ilmenite. The soil of the area consists of red earth and black cotton clay. Sections of the rock show angular to subangular quartz grains, cemented together in a ferruginous matrix. Felspar, magnetite, ilmenite and epidote are noted.

The well is believed to be in existence from the time of King Varaguna Pandian (about 860 A.D.) and gives an yield of only 9 gallons an hour. The water is chalybeate, soft, colourless; shows a faint turbidity in transmitted light, and slight opalescence in reflected light. On exposure to air it sets free a reddish flocculent precipitate of hydrated iron-oxide.

Chemical Analysis:—Five litres of filtered water were used for the determination of total solids.

	Parts per 100,000
Total Solids	28·6
Chlorides as chlorine	0·7
(equivalent to NaCl)	1·1
Silica	16·4
$Fe_2O_3 - Al_2O_3$	1·5
Lime as CaO	0·5
Magnesium as MgO	0·06
Ba, Mn, F_2, Li, P_2O_5 and B	*nil*

Spectroscopic Analysis:—This analysis was carried out in the laboratory of The Indian Association for the Cultivation of Science, Calcutta, by Mr. P. K. Seshan under the guidance of Prof. K. S. Krishnan, F.R.S.

IRON IS TAKEN AS UNITY

0·5 to 0·1	0·1 to 0·01	0·0001 or less	Not detected
Sodium	Potassium	Manganese	Arsenic
Calcium	Magnesium	Lead	Bismuth
Aluminum	Chromium	Copper	Gold
Barium	Tin	..	Silver
Strontium	Titanium	..	Zinc
..	Rubidium	..	Cobalt
..	..	..	Nickel
..	..	..	Beryllium

There is a general belief that a continuous and liberal use of the water has produced beneficial effects in heart troubles, pains in the joints, kidney affections and menstrual complaints. A thorough clinical study may prove valuable.

T. N. MUTHUSWAMI.

Presidency College,
Triplicane, Madras,
March 7, 1941.

CHROMATIN BRIDGES IN THE ROOT TIP OF GROUNDNUT

CHROMATIN bridges were observed at anaphase and telophase of somatic mitosis in root tip cells in germinating seeds of certain varieties of groundnut. In some cells a single bridge was noticed per cell and very occasionally a fragment was also present along with the bridge. In a very few cases, two bridges were observed in a cell. Chromatin bridges are of frequent occurrence in meiosis and have also been produced artificially by means of X-rays. But very few instances are on record of the occurrence of bridges in root tip cells. Mensinkai[1] considered that the bridges he noticed in *Allium* might have been formed by the union of the ends of sister chromatids. Sikka[2] assumed that the bridges in *Brassica* originated by the breaking of the chromosomes at the point of overlap in the preceding interphase and subsequent fusion of the broken ends.

FIG. 1

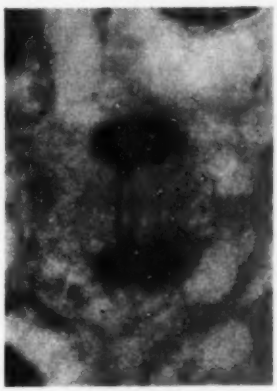


FIG. 2

Jacob[3] attributed the formation of bridges in *Clitoria* to the probable reciprocal translocation between two homologous chromosomes. Pathak[4] recorded of chromatin bridge in the root tip of *Crocus*. Nicholas[5] noticed bridges in some *Allium* varieties and concluded that 'dehydration, heat and age may cause a weakening of the chromosomes so that breaks occur at the beginning of the activity in the nucleus giving rise to aberrations which result in bridge formation'. In view of the interesting nature of the chromatin bridges and the fact that the occurrence of these in root tip cells has been recorded only in a very few cases till now, the formation of bridges in the root tips of groundnuts is herein recorded. Fig. 1 shows a bridge

and a fragment in an indigenous variety of *Arachis hypogæa* L., and Fig. 2 shows two bridges connecting the daughter nuclei in *Arachis nambyquaræ* Hoehne.

C. N. Babu.

Oil Seeds Section,
Agricultural Research Institute,
Lawley Road P.O.,
Coimbatore,
March 5, 1941.

1 Mensinkai, S. W., *Jour. Genet.*, 1939, **39**, 1.
2 Sikka, S. M., *Ibid.*, 1940, **40**, 441.
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5 Nicholas, C., *Genetics*, 1941, **26**, 89.

CERTAIN ABNORMALITIES IN THE ROOT TIPS OF COTTON

In a cytological examination of the root tips of cotton by the "Feulgen Fast Green technique"[1] the following abnormalities, not reported in this genus before, were observed.

1. Ring chromosomes were occasionally observed in *Gossypium herbaceum* L. var. *africanum* H. & G. at metaphase (Fig. 1). They

Fig. 1

Mitotic metaphase in *G. herbaceum* var. *africanum* showing a ring chromosome. × 2600.

have been previously reported in a few genera like *Crepis*,[2] *Zea*,[3] *Drosophila*[4] and *Sesbania*.[1]

2. Lateral satellites were observed in two instances. Fig. 2 shows the thread of the lateral

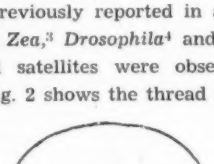

Fig. 2.

Mitotic prophase in *G. arboreum* var. *typicum* showing one chromosome with a lateral satellite attached to the nucleolus × 2600.

satellite attached to the chromosome at its constriction in prophase in *G. arboreum* L. var. *typicum* forma *indica* H. & G. Its homologue bears a terminal satellite. This appears to have been caused by the inversion of the satellited segment of the chromosome. Since the lateral satellite is attached to the nucleolus, it has to be assumed that the "nucleolar organising body" was not lost during this structural change. A similar instance has been reported only in *Sesbania grandiflora*[1] before.

Fig. 3 shows a metaphase plate in *G. herbaceum* L. var. *frutescens* Delile ("Uppam" 2919")

Fig. 3

Mitotic metaphase in *G. herbaceum* var. *frutescens* showing one chromosome bearing a lateral satellite.

where one chromosome bears a lateral satellite. This is longer than the normally satellited chromosome in the complement as may be seen from the figure. This necessarily means that the satellite is translocated to a longer chromosome from the normal one. Instances of chromosomes bearing lateral satellites have been reported in a few other plants like *Tradescantia*,[5] *Allium*,[6] *Crepis*,[7] *Clitoria*[8] and *Narcissus*.[9] Mather and Stone[10] in *Crocus* and Camara[11] in *Alœ* and *Vicia* also observed lateral satellites in materials treated with X-rays.

3. Cytomixis in root tips. Fig. 4 is a photomicrograph of a cross-section of the root tip in *G. herbaceum* var. *frutescens*. This root appears to have been ruptured at places A and B. Fig. 5 shows the contents of the nucleus of one cell passing into the other, the nucleolus alone being left behind. A number of 'normal cells' surrounding the injury (not the injured cells) exhibited this phenomenon to varying degrees.

Cytomixis in root tips have been reported

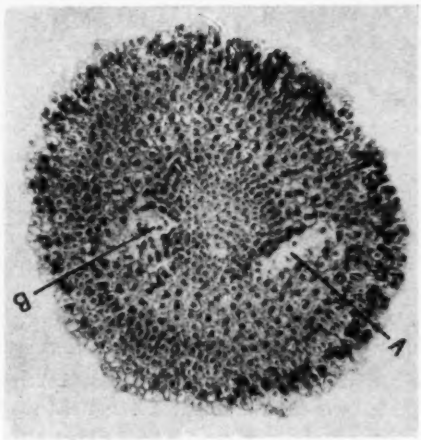

FIG. 4

Photomicrograph of the cross-section of a root tip in *G. herbaceum* var. *frutescens* showing the tissues ruptured at two places, A and B.

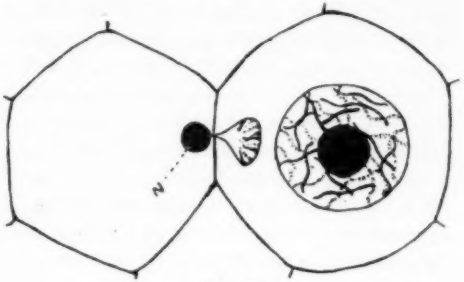

FIG. 5

Two cells enlarged to show the details of cytomixis. ×2600.

only in two instances previously (*Clitoria ternata*[8] and *Sesbania Sesban*[1]). But this phenomenon in flower buds was first reported by Gates[12] at meiotic prophase in *Œnothera gigas*, where he observed the transference of chromatin between two contiguous cells through gaps in the cell walls by means of protoplasmic connections. Subsequently a number of investigators have reported this phenomenon at meiosis from prophase of first division to telophase of second division. Katterman[13] and Jacob[1] have reviewed the relevant literature on the subject.

A few investigators hold the view that this phenomenon is brought about by the action of fixatives. But the experiences of the author and other investigators in several plant genera do not lend any support to this view. That such a phenomenon goes on in nature is unquestionable, but its causes are not quite clear. As pointed out by Gates and Rees[14] in *Lactuca*, this phenomenon is certainly an abnormal one, which may even indicate a pathological condition.

K. T. JACOB.

Cotton Breeding Station,
Coimbatore,
February 28, 1941.

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[2] Navashin, M., *Univ. Calif. Publ. Agr. Sci.*, 1930, **6**, 95.
[3] McClintock, B., *Proc. Nat. Acad. Sci.*, 1932, **18**, 677.
[4] Morgan, L. V., *Genetics*, 1933 **18**, 250.
[5] Darlington, C. D., *J. Genet.*, 1929, **21**, 207.
[6] Levan, A., *Hereditas*, 1932, **16**, 257.
[7] Swezy, O., *Cytologia*, 1935, **6**, 266.
[8] Jacob, K. T., *Ann. Bot. N. S.*, 1940, **4**, 201.
[9] Sikka, S. M., *Ann. Bot. N.S.*, 1940 **4**, 427.
[10] Mather, K., and Stone, L. H. A., *J. Genet.*, 1935, **28**, 1.
[11] Camara, A., *Bull. Soc. Ital. Biol. Sperim.*, 1939, **17**, 46.
[12] Gates, R. R., *Ann. Bot.*, 1911, **25**, 909.
[13] Kattermann, G., *Planta*, 1933, **18**, 751.
[14] Gates, R. R., and Rees, E. M., *Ann. Bot.*, 1921, **35**, 365.

SOME UNUSUAL MEGASPORE TETRADS IN THE LEGUMINOSAE

IN all Leguminosæ investigated so far, the megaspore-mother cell has been observed to form mostly a linear or occasionally a T-shaped tetrad of megaspores. In a few cases, *e.g.*, *Phaseolus vulgaris*[1,2] and *Accacia baileyana*,[3] etc., only three megaspores (really a row of two megaspores and a dyad) have been reported. This results from the absence of the second meiotic division in the micropylar dyad. Of the megaspores formed, generally the chalazal one or the one adjacent to it is functional, and develops into the embryo-sac according to the *normal*-type. The rest degenerate.

While studying the embryology of the Leguminosæ, the writer has come across two unusual types of megaspore tetrads in *Cassia glauca* Lamk. var. *suffruticosa* Koenig. and *Desmodium gangeticum* DC. In the former species a linear tetrad of megaspores is the general rule and the chalazal megaspore develops into a normal 8-nucleate embryo-sac as in the Leguminosæ in general. In one case, however, where two megaspore-mother cells were seen developing side by side in the same ovule, one of the megaspore-mother cells had formed a bilateral tetrad of megaspores (Fig. 1).

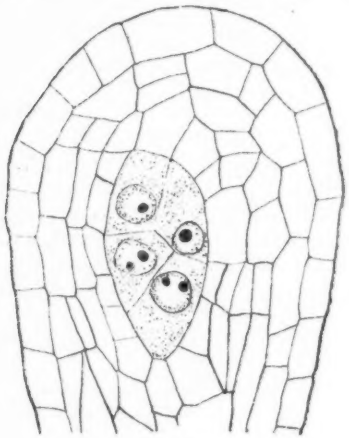

FIG. 1

Cassia glauca var. *suffruticosa* Nucellus with an isobilateral tetrad of megaspores. × 750.

This form of the tetrad is quite common among pollen grains, but is rather rare among megaspore tetrads. Coulter and Chamberlain[1] recorded one instance, namely, *Fatsia Japonica* studied by Ducamp. In a more recent review Maheshwari[5] mentions two more cases, *Myrtus communis*[6] and *Urginea indica*.[7]

In the case of *Desmodium gangeticum* also normally a megaspore-mother cell gives rise to a linear tetrad of spores and the chalazal megaspore is the functional one, but in one instance the chalazal dyad during the second meiotic division had divided longitudinally while the micropylar dyad had divided transversely as in normal tetrads. This had resulted in the formation of an 'inverted T-shaped' tetrad (Fig. 2). Until recently this type of tetrad was known

FIG. 2

Desmodium gangeticum ⊥-shaped tetrad of megaspores. × 1350.

only in the *Onagraceæ*, where the micropylar megaspore is the functional one and the resulting embryo-sac is of the *Œnothera*-type (monosporic 4-nucleate). It has been seen in *Anogra pallida* and *Zauschneria latifolia* by Johansen[8,9] (1931 *a*, *b*) and in *Ludwigia parviflora* by Maheshwari and Gupta.[10] Last year, however, Dr. Kajale[11] from this laboratory reported, for the first time, this type of tetrad in a form with the *normal*-type of embryo-sac, namely, *Cyathula tomentosa*, a member of the *Amarantaceæ*. *Desmodium gangeticum* is the second species with the *normal*-type of embryo-sac to show this kind of megaspore tetrad. In tetrads of this type the question arises as to which of the megaspores would function. In *Desmodium gangeticum* one of the two chalazal megaspores was seen to have increased in size and developed vacuoles, as shown in the figure. It is very likely that this would develop into the embryo-sac.

The writer is indebted to Dr. A. C. Joshi for help in the preparation of this note.

J. V. PANTULU.

Benares Hindu University,
February 5, 1941.

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2 Weinstein, A. J., *Amer. Jour. Bot.*, 1926, **13,** 248.
3 Newman, I. V., *Jour. Linn. Soc.*, 1933, **49,** 145.
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5 Maheshwari, P., *New Phytol.*, 1937, **36,** 5, 359.
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9 ———, *Amer. Jour. Bot.* 1931, **21**, 508.
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11 Kajale, L. R. *Proc. Nat. Inst. Sci.*, 1940, **4,** 597.

ORIGIN OF BICOLLATERAL BUNDLES IN THE PETIOLE OF *HERACLEUM SPHONDYLIUM*

INTRAXYLLARY (internal) phloem associated with primary vascular bundles of the collateral type occur in a large number of families of Dicotyledons (De Bary,[1] Solereder,[2] Eames & MacDaniels[3]). De Bary[1] introduced the term 'bicollateral' or double collateral to designate such bundles where "two phloem groups lie on opposite sides of one xylem group" (pp. 319, 338), but the type of collateral bundles found in the Cucurbitaceæ is seen, so far as I know, in no other families where the occurrence of such bundles has been reported. As a matter of fact Herail thinks that true bicollateral bundles exist only in the Cucurbitaceæ (Sol. I, p. 394).

Investigators are not unanimous as to the way in which the internal phloem of a bicollateral bundle originates. De Bary thought that in cases where phloem abutted directly on the xylem its origin was procambial, but where an intercalary parenchyma separated them the origin was independent and was in the ground meristem.

Lamounette,[4] however, reported that internal phloem takes origin not in the procambium but in the parenchyma internal to it. Researches in the Botanical Laboratories of the Presidency College confirm Lamounette's observations so far as the Cucurbitaceæ are concerned. Esau,[5] who worked on the ontogeny and structure of the tobacco phloem, also found internal phloem differentiating from the ground meristem cells, but she observed that "when internal phloem just begins to differentiate they (the ground meristem cells) cannot be sharply delimited from the procambium" (p. 398).

Eames and MacDaniels[3] give altogether a different story of the origin of the internal phloem. They write that "branches depart from the phloem strands of roots at the level where root structure begins to change, pass inward and come to lie inside the new xylem strands, establishing bicollateral bundles" (p. 244).

All workers, however, agree that the internal phloem is always later in appearance than the external phloem of a bicollateral bundle.

In *Heracleum* the origin of bicollaterally, which may be regarded as an instance of abnormality, is effected by the fusion of two independent collateral bundles. The leaf is differentiated into a sheathing base, a petiole and a laminar region. In the base the numerous bundles are all arranged in one subepidermal level, but when they enter the petiole the lateral ones from the wings divert their courses and come to lie in two rows with their xylem almost face to face in the middle region of the petiole (Fig. 1), the central ones retaining their subepidermal position. Some of the

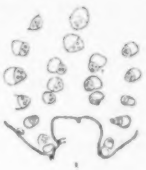

FIG. 1

FIGS. 1, 2, 3. T.S. of petiole. Fig. 1, camera lucida drawing showing central bundles in two rows (× 60); figs. 2. 3 photomicrographs of stages shewing the formation of a bicollateral bundle by the fusion of two collateral bundles.

lateral bundles during their course upwards come closer together, start fusing by their xylem regions (Fig. 2), their free phloem portions

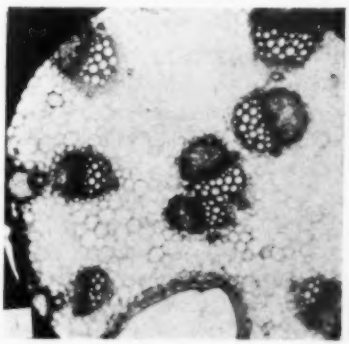

FIG. 2

orient through 90° or more degrees, and after complete fusion of the xylem strands form a typical bicollateral bundle of the Cucurbita type (Fig. 3). Joshi[6] describes and depicts a

FIG. 3

similar stage in the formation of a amphixylic type of vascular bundle by the union of two collateral medullary bundles in *Achyranthes aspera* (Joshi, Fig. 6 *a*, *b*; p. 270).

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Department of Botany,
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Calcutta,
February 21, 1941.

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[2] Solereder, *Systematic Anatomy*, 1908. 2 Vols.

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TESTES IN THE ADULT COCKROACH, *PERIPLANETA AMERICANA* LINN.

THE cockroach is commonly used as a type for dissection and study in all the Indian Universities. Unfortunately the descriptions of the structure and function of testes of the common cockroach, *Periplaneta americana*, in the ordinary text-books[1,2,3] are vague and confusing. It is admitted by most authors that the testes in this species are very difficult to find and they are non-functional at its adult stage, although in *Blatta germanica* they are reported to be functional throughout life. Miall and Denny[4] state that in the adult cockroach the testes atrophy and are non-functional. To clarify the descriptions we investigated the reproductive system of the cockroach, *Periplaneta americana*. The testes (Fig. 1) are elongated

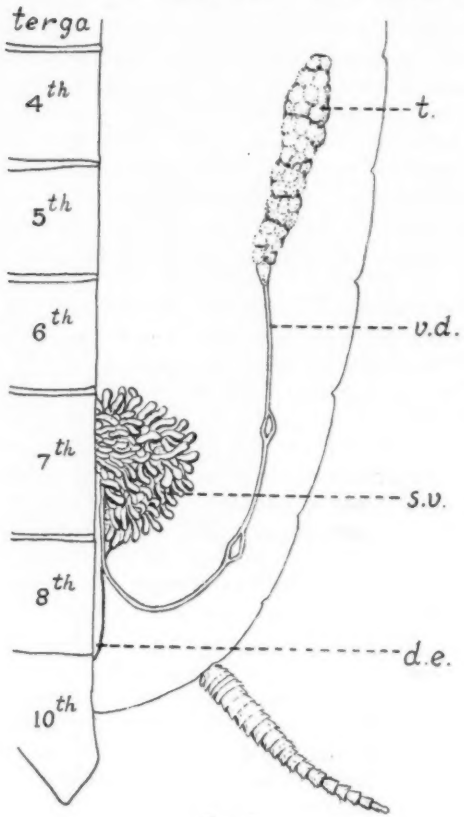

FIG. 1

Male reproductive organs of *Periplaneta americana* Terga shown on the left-hand side; *t.*–testis; *v.d.*–vas deferens; *s.v.*–mushroom-shaped gland; and *d.e.*–ductus ejaculatorius.

structures composed of small distinct globules resembling a bunch of grapes; they are conspicuous by size and are enveloped by fat. They are easily noted on the inner sides of the fourth and fifth abdominal segments. In no case we find them in the atrophied condition or shrivelled as pointed out by Miall and Denny.[4] In the adult with wings fully developed and measuring (with head deflexed) 4·4 cm. in length, the testes are 1 cm. in length and the vas deferens 1·6 cm. If a portion of one of the

testes of the adult cockroach is teased in normal salt solution (0·75 gm. in 100 c.c. of distilled water) and examined under the high power of the microscope, the spermatozoa are seen to be actively motile. Quite a number of adult male specimens of *Periplaneta americana* has been dissected and examined microscopically, in all cases active spermatozoa were found and the testes did not show any sign of atrophy, nor were smaller in size. We have also compared their minute structure with those of younger stages, and we are of opinion that the testes in the adult stage do not materially differ from those of the younger stages in which alone the previous authors[4] observed the existence of developed reproductive glands. Details will be published elsewhere.

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Haridas Mitra.

Department of Zoology,
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February 6, 1941.

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[4] Miall and Denny, *The Cockroach*, 1886.

A STATISTICAL EXAMINATION OF TASTE DIFFERENCES IN BAJRA VARIETIES

Bajra (*Pennisetum typhoideum*) is one of the important food crops of the population in Baroda State. Several varietal trials have therefore been conducted at the Baroda Agricultural Experimental Station for finding out the most suitable variety for the tract. Jamnagar Giant, an African variety, introduced from Jamnagar State in 1935, was one of the varieties included in these trials; but it was found that public opinion was much against it in the matter of taste, which is one of the factors against its extensive cultivation. Since taste is an important factor in any new introductions of food crops an experiment was conducted to determine the taste differences in the different varieties quantitatively. It was further thought that the result obtained would be of general scientific interest since it would show whether varietal differences in such a complex character as taste could be objectively studied by the application of the modern statistical methods.

The material for the test consisted of seven varieties of *bajra* grown at the Baroda Agricultural Experimental Station. These seven varieties were further mixed together to make a bulk and thus eight samples in all were studied. The different samples were finely ground in a common household *chakki* under as uniform conditions as possible. The flour was used in two separate trials.

In trial A, bread was prepared from the flour of the eight samples by a woman expert in this operation. Care was taken to ensure all possible uniformity in such matters as the amount of water used to make the dough, the thickness of the bread and the degree of roasting. The samples of bread were then alphabetically labelled. Eighteen members of the farm staff were invited to taste the samples and put the varieties in the order of their tastefulness. The samples were served hot, first in a random order and then as desired by each taster until he came to a definite conclusion. No consultation or any discussion between the tasters was allowed. The varieties were ranked from the least tasteful upwards so that the most tasteful variety was ranked eighth.

In trial B, the flour of the eight samples was given to two intelligent families, one that of a District Judge with five adult members, and the second, a College Professor's family with three adult members. The names of the varieties were not disclosed. In this trial it was possible to score each variety independently with a maximum of ten marks for the most tasteful sample.

The results obtained were statistically examined by the analysis of variance in the two trials.

Trial A.—The varietal totals arranged in a descending order, the standard error percentage of the mean and the significant difference between the total scores of any two varieties are given below:—

Name of the variety	Amreli	Baroda	Jamnagar Giant	Akola 136	Akola 141	Sathi	Jagudan	Bulk
Total marks	121	108	94	82	80	70	49	44

Standard error % of the mean, 9·8.
Significant difference between variety totals, 22·5.

Fisher and Yates[1] have given tables for converting such ranked data into normal scores for the purpose of statistical analysis. The data were therefore re-examined after transformation into normal scores but the resulting analysis of variance and the significance of the difference between varieties were very similar to those obtained by the analysis of the original data and confirmed the validity of the conclusions to be drawn.

The analysis of variance clearly shows that varietal differences were quite distinctly significant. The locally favoured varieties Amreli and Baroda occupy the first two places. It is remarkable that Jamnagar Giant, against which there is a considerable amount of prejudice, takes the third place and is thus classified along with the best varieties. Another interesting result is that the bulk which is a mixture of all the varieties in the trial occupies the lowest place. It is clear that due to its heterogenous composition its taste was not appreciated. The comparatively low standard error attained indicates that it is possible to perform experiments of this kind with a considerable degree of accuracy.

Trial B.—The varieties are arranged below according to their total scores:—

Name of the variety	Baroda	Jamnagar Giant	Akola 141	Akola 136	Amreli	Jagudan	Sathi	Bulk
Tota. scores	71	70	59	45	35	28	25	18

Standard error % of the mean, 13·4.
Significant difference between variety totals, 16·6.

It will be seen that except for the change in the position of the Amreli variety the results of these two indepedent trials agree with each other very closely. An explanation of the discrepancy with regard to Amreli may be found in the fact that the majority of the persons taking part in trial A belong to the farming community in Gujerat who show a general preference for the Amreli variety whereas the members of families in trial B have no reasons for such preference. There is little doubt that there is no ground for the prejudice against Jamnagar Giant as far as its taste is concerned.

The results have demonstrated that taste can be studied objectively by the application of modern statistical methods, that Jamnagar Giant variety of *bajra* was consistently classed among the best varieties and that the local prejudice against this variety was not well founded.

I am indebted to Mr. R. G. Allan, Commissioner of Agriculture, for his encouragement in undertaking this investigation, to Dr. V. G. Panse of the Institute of Plant Industry, Indore, for his help in the statistical analysis of results and to the various persons who co-operated in the investigation.

G. K. Govande.

Economic Botanist to Government,
Baroda,
February 13, 1941.

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A QUICK AND SIMPLE PROCEDURE FOR THE ESTIMATION OF VITAMIN B_1 IN RICE

The vitamin B_1 content of Co. 9 raw husked (wooden huller) rice was determined by the biological method according to the technique of Scheunert and Schieblich.[1] The rice contained 200 I.U. or 600 γ per 100 grams. The results of the biological assay are given below;

TABLE I

Groups	Daily dose of supplement per rat: Co. 9 raw husked rice gm.	No. of rats	Sufficient	Insufficient: Decrease of wt. > 2 gms.	Cramps	Cramps and died	Died
I *a*	0·5	10	10	—	—	—	—
b	0·25	10	9	1	—	—	—
c	0·20	10	5	5	2	2	1
	Synthetic Vitamin B_1 I.U.						
II *a*	0·6	10	9	1	—	—	1
b	0·5	10	9	1	—	1	—
c	0·4	10	5	5	—	3	2

A sensitive Cohen's[2] type of photoelectric fluorometer which gave a deflection of 50 mm. per γ of vitamin B_1 and a blank of 10 mm.

TABLE II

No.	Strength of HCl	Kept overnight at	γ Vitamin B_1 per 100 grams of Co. 9 husked rice (observed)	Computed value γ Vitamin B_1 per 100 grams	Recovery %
1	0·1N	37° C.	267		
2	0·1N	Room Temp.	267		
3	0·5N	37° C.	298		
4	0·5N	Room Temp.	307		
5	1·0N	37° C.	304		
6	1·0N	Room Temp.	302		
7	0·5N	4 Hrs. shaking	298		
8	0·5N	2 Hrs. ,,	300		
9	0·5N	1 Hr. ,,	295	490	60
10	0·1N + Pepsin (Pyke[3])	57° C.	372	510	73
11	0·1N + Pepsin (Pyke[3]) + Taka diastase[3]	5 Hrs. at 37° C.	365	507	72

was constructed with a colour filter of methyl violet and copper chloride so that only the fluorescent energy of thiochrome was allowed to pass through and fall on the photoelectric cell.

The above procedure (Table II) for the extraction of vitamin B_1 from rice were tried.

It is evident from the above results that the maximum of vitamin B_1 is extracted in the minimum time according to procedure (9). The results according to the procedures 9, 10 and 11 do not show the presence of either combined vitamin B_1 or cocarboxylase in the rice under investigation. The vitamin B_1 of the Co. 9 raw husked rice was estimated according to the method of Hills[4] (where the blank value is eliminated) and found to contain 510 γ per 100 grams of the rice which is in close agreement with the computed values according to procedures 9, 10 and 11 (Table II). A series of vitamin B_1 determinations in Co. 9 husked rice were made and the standard deviation and standard error were calculated. They were found to be 4·8 and 1·8 respectively.

In conclusion the following quick, simple and elegant method for the estimation (Thiochrome method) of vitamin B_1 in rice is recommended.

To two glass stoppered bottles 5 gm. of rice are weighed out and 50 c.c. of 0·5 N HCl are added to each. To the second bottle a known quantity of standard vitamin B_1 solution is pipetted out (to estimate the per cent. recovery of added vitamin B_1). Both the bottles are tightly stoppered and shaken for one hour on a shaking machine. Then the contents are centrifuged for 5 minutes. 3 c.c. of the centrifugate from each are used for the estimation of observed value and per cent. recovery of added vitamin B_1 respectively according to the original method of Jansen.[5] For 3 c.c. of the rice extract it is found that 1 c.c. of 1 per cent. potassium ferricyanide is the optimum quantity. Two different standard vitamin B_1 solutions are tested every time a reading is taken to determine the sensitivity of the fluorometer. The greater volume of the solutions when vitamin B_1 is added for recovery experiments is taken into account for calculations. The

vitamin B_1 content of the rice is calculated from the results of the observed value and per cent. recovery of added vitamin B_1.

The vitamin B_1 content of a few varieties of rices by the above procedure are given below:

TABLE III

Rice		Colour	γ Vitamin B_1 per 100 gms. (observed)	γ Vitamin B per 100 gms. (computed)	Recovery %
Co. 9 raw husked (wooden huller)		Red	300	500	60
Adt. 11	Do.	White	302	409	74
GEB 24	Do.	,,	279	490	57
Co. 4	Do.	,,	307	404	76

The details of this paper and further work on the vitamin B_1 content of other cereals and pulses according to our procedure will be published elsewhere.

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March 12, 1941.

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[2] Cohen, *Rec. Trav. Chim.*, 1935, **54**, 133.

[3] Pyke, *J. Soc. Chem. Ind.* 1939, **58**, 338.

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[5] Jansen, *Rec. Trav. Chim.*, 1936, **55**, 1046.

A NOTE ON DR. KAJALE'S RECENT PAPER ON THE AMARANTHACEAE

RECENTLY Dr. L. B. Kajale[1] has published an exhaustive work on the Embryology of the *Amaranthaceæ* in which he has made some very valuable additions to our knowledge of this family. On p. 610 of his paper he mentions having found one instance in *Cyathula tomentosa* in which the four megaspores of the tetrad were arranged in the form of an inverted "T". Three other instances of a similar kind are quoted from previous literature:—*Zauschneria latifolia*,[2] *Angora pallida*[3] and *Ludwigia parviflora*.[4] Since the development of the embryo-sac in all these plants is of the *Œnothera*-type, Dr. Kajale goes on to add that in forms with a normal type of development such an arrangement of megaspores is unknown, his being the first recorded instance of the kind.

Dr. Kajale is right with regard to the rarity of this phenomenon in families other than the Onagraceæ. Its more frequent occurrence in the latter is obviously related to the fact that here the micropylar megaspore usually functions in preference to the chalazal and hence any irregularity with regard to the normal position of spindles in the homotypic division would occur in the chalazal rather than in the micropylar dyad cell. Megaspores arranged in the form of an inverted "T" are, however, not unknown in other plants. Schnarf[5] quotes Baranow (1926) as having seen such an arrangement in *Drimiopsis maculata*, Paetow[6] has observed it in *Tacca viridis* and Copeland[7] (1938) in *Styrax officinalis*. I have not particularly hunted the literature for this abnormality and would not be surprised if still other cases of a similar nature are present in earlier records.

While new reports of abnormalities and rarities are always to be welcomed, it seems necessary to warn the enthusiast from being over-confident of the priority of his own observations.

P. MAHESHWARI.

Biology Department,
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February 17, 1941.

[1] Kajale, L. B., *Proc. Nat. Inst. Sci. India*, 1940, **6**, 597.

[2] Johansen, D. A., *Ann. N.Y. Acad. Sci.*, 1931, **33**, 1.

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HETEROPODA VENATORIA PREYING ON A PIPISTRELLE BAT

THAT some spiders feed on vertebrates is now unquestionable. Records of account of different vertebrates, such as fish, frogs, lizards, snakes, rats, etc., being captured and fed on by different species of spiders in different parts of the world are available.[1-9] But record of any instance of spiders preying on tiny bats has not been known to me. Recently, however, I had the rare opportunity of recording an instance of the kind.

In a neighbouring village of Calcutta in a cow-shed surrounded by matted wall I witnessed a spider, *Heteropoda venatoria* Linn., preying upon a tiny bat, *Pipistrellus* Sp. Entering into the shed I noticed a pipistrelle bat struggling to drag itself out of a crevice between two bamboo strips of a wall and a big house-spider, *H. venatoria*, was seen firmly gripping the former by the neck with its powerful mandibles. There was intermittent gasping and screaming of the bat. It was dark within the shed and a torch was focussed on the spot. As soon as the light fell upon the spot, the bat screamed loudly and came out of the crevice by vigorous flapping of its wings. The spider at the same time tried its utmost to stick to the spot. The bat, however, could drag itself away a certain distance on the matted wall by crawling with its peculiar habitual gait with the help of its fore-arms, the spider all along keeping its hold. In the strife the bat was completely exhausted. After a stay in that condition for about fifteen to twenty minutes it began to flap its right wing and at the end stretched it to its utmost. Remaining in that position for a minute or two the wing slowly regained its normal position like a stretched-out limb in an atonic condition. By careful manipulation I captured the combatants and brought them home in a glass jar. They were left undisturbed for the night. Next morning the spider was found resting at the top of the jar in an upside down position and the victim was lying stiff at the bottom with the only visible injury on the neck. Evidently the bat had expired long ago and remained untouched by the spider during the night.

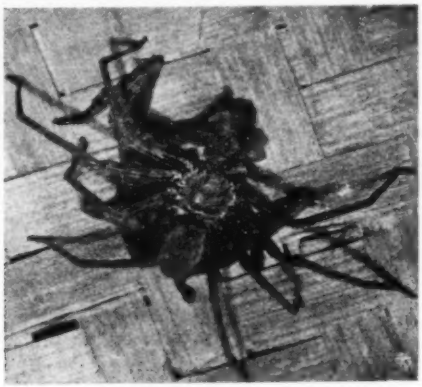

FIG. 1

The spider *H. venatoria* gripping the pipistrelle bat with its powerful mandibles.

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Bose Research Institute,
Calcutta,
March 3, 1941.

[1] Cambridge, *Proc. Zool. Soc.*, Lond., 1903, **1**, 152, 158.
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[7] Hutton, *Journ. Asiatic Soc. Beng.*, 1842, **11**, 860.
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SOIL SOLUTION STUDIES IN IRRIGATION PRACTICES

(With special reference to Alkaline and Saline Soils)

IN a previous paper the writer and Pollard[1] have described in detail the practical significance of soil solution studies. Methods of obtaining the soil solution and estimating various bases, fertility ingredients, and soil relations are examined and described. Value of soil solution methods has been critically examined and their application to investigation of

causes of soil productivity and exhaustion has been described.

The soil solution studies have further been extended and a detailed inquiry into the soluble salt status of alkaline and non-alkaline (healthy) soils in relation to irrigation practices has been made. Full data will soon be published.

By use of small-scale drain pipe lysimeters (*vide* plate given) permitting detachment of their contents in a number of separate layers, changes in the composition of soil solution and the movement of its mineral constituents resulting from irrigation and from the upward movement of waters are examined. The technique developed is shown to contribute extensively to the solution of problems likely to arise in connection with irrigation practices.

It is found that the addition of sodium chloride to soils results in (*a*) a depression of the solubility of phosphates, the action being

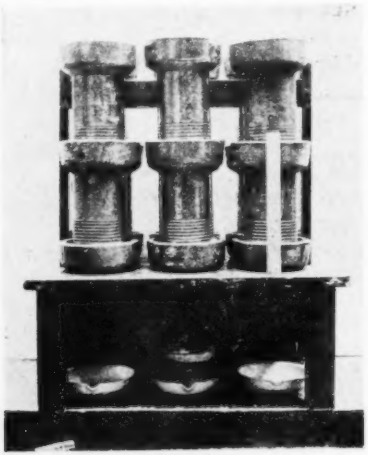

FIG. 1

reversible when sodium chloride is removed by irrigation, drainage, etc., (*b*) mobilisation of organic nitrogen constituents which thus become capable of upward and downward movement in the soil, (*c*) mobilisation of iron, aluminium, manganese, in soils of low but not in those of high lime content.

Examination of leachings, and soil solution from artificial and natural saline soils under various conditions show a general similarity of all characteristics examined. Use of artificially salted soils, therefore, appears to offer a reliable experimental basis for investigation of problems concerned notably with irrigation of saline soils.

Comparison is made of the composition of displaced soil solution and that of corresponding water extracts in which the soil-water ratio is varied. Soil extracts are shown to indicate much larger proportion of soluble calcium, potassium, carbonate, phosphate, and higher calcium-sodium ratio (on dry soil basis) than actually appear in the soil solution. The use of water extracts in assessing the proportion of soil fertility ingredients or harmful soluble salts (in case of saline soils) seems somewhat unsatisfactory.

Liberal use of irrigation water improves the salt status of almost all saline soils in surface layers, whereas such heavy doses drain off available plant food material from healthy soils. In case of salt-free healthy soils, judicious and economical use of irrigation water is recommended for maintenance of high level of soil fertility.

The new methods assist in the determination of soil nutrient values preparatory to prescribing profitable manurial treatments.

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February 25, 1941.

[1] *Indian J. Agric. Sci.*, 1939, **9**, 473.

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